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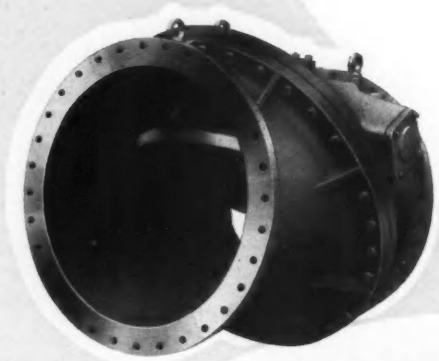

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THE ENGINEER

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AD ASTRA

Amongst engineers neither directly nor indirectly interested in the technical problems of constructing rocket weapons or engines little notice has been taken of talk about interplanetary travel. It has seemed a waste of time, entertaining though it may have proved to delve into some book, intended for children, descriptive of the dare-devil exploits of an adventurer armed with a space-gun in his travels to the Moon, Mars and Venus. Yet within about twelve months the first step will have been taken to demonstrate that interplanetary travel may become practicable in the engineering sense within the not altogether distant future. For both the Americans and the Russians intend, as parts of their respective contributions to the International Geophysical Year, to set up artificial satellites circling the earth under gravitational forces. Those objects, it is true, will neither be very big, at less than 2ft diameter, nor very far up, at only 300 miles or so. But it is planned that they shall be sufficiently far up for the residual atmospheric density at that altitude to exert only very small forces resisting their motion, and it is hoped that they will continue to orbit round the earth at a rate of one circuit every ninety minutes or so for at least several weeks before those forces cause them to descend to lower altitudes and eventually to burn up in the earth's atmosphere.

Some further particulars about the American satellites were made available last week by Mr. Howard Perkins, president of the firm that is manufacturing them. No doubt the Russian examples will be similar. Each satellite—about twenty are at present planned for manufacture—will consist of a hollow sphere of magnesium alloy AZ 21 about 20in in diameter. In designing these objects the conditions to be met relate far less to those likely to be encountered once they have been established on orbit than to those which will exist while they are being lifted by rocket power. It is true that no one knows at all precisely what the temperature of the objects is likely to be when in service nor what variations of temperature they will have to withstand. Nor is it known to what extent they will have to withstand punishment from high-velocity meteors falling towards the earth. One of the objects of the experiment in establishing artificial satellites is, in fact, to discover the answers to those questions. The more important factors influencing the design are those imposed by the high acceleration each satellite will have to withstand while being lifted from the earth's surface, the increase of temperature brought about by friction with the earth's atmosphere during the earlier part of the same period, the imperative need for lightness imposed by the bare sufficiency of the rocket power available, the desire of scientists to pack as much equipment as possible within a satellite and their desire that the objects shall be pressure tight for an internal pressure equal to 1 atmosphere. Heating during acceleration has turned out to be not very serious; the highest temperature likely to be reached is only of the order of 400 deg. Fah. For lightness the spheres will be manufactured from sheet magnesium about $\frac{1}{32}$in thick pressed to hemispherical form and subsequently machined down to about 0·032in thickness. Two such hemispheres will be connected together either by a welding process or with a mechanical joint, and there will be an internal tubular structure to support the whole against the stresses set up during acceleration and to carry scientific equipment. The exterior will be highly polished to provide high reflectivity.

In an article in the American Section in our issue of August 17th a full description was given of the method of launching the satellites. The setting of the satellites on orbit is clearly very near the edge of the possible under present experience in the design of rockets. The weight of each satellite at about 20 lb is about one-thousandth of the weight of the complete rocket as it leaves the earth. The three-stage rocket will have only just sufficient power to lift this small body to a height of about 300 miles and to accelerate it and the burnt-out "bottle" of the third-stage rocket, incapable of carrying any useful equipment, to a speed of about 25,000ft per second. Scientists, naturally, would like to include a great variety of equipment in the satellites. But in the engineering sense the experiment will have proved a success as soon as a satellite is established in a satisfactory orbit. That in itself will be a remarkable achievement. For the rockets will have so little power to spare that a quite fine degree of accuracy will need to be attained in assuring that when acceleration ceases and the satellite parts company with the third-stage "bottle," the direction of motion shall be at right angles to a radius from the earth's centre. Any quite small divergence from that direction of travel, regardless of the speed, must necessarily mean that the perihelion of the orbit will be closer to the earth's surface than the point of release of the satellite, with the consequence that, owing to the higher residual atmospheric pressure at lower levels, the life of the satellite will be shortened. The speed to be attained is only less critical in that so long as a

minimum is surpassed all will be well. If the satellite is to make no closer an approach to the earth than its distance at release, the speed must be at least equal to that of an object travelling in a circular orbit. Any excess above that speed will elongate the orbit outwards. The attainment of these desiderata is, of course, critical because the satellites will be established at such relatively low altitudes. Were the altitude to be much less than 300 miles at perihelion the lives of the satellites—dependent upon the unknown rate at which atmospheric pressure falls off at such altitudes—might prove quite transitory. It will be clear from the foregoing that the setting up of artificial satellites constitutes only a very short step towards interplanetary travel. There is still a long way to go before rocket engineers will be able to build a vehicle capable of generating escape velocity and thus capable of travelling to the moon and other planets of the Solar System. Yet next year the first small step towards the attainment of such an objective will have been taken.

IN COMMEMORATION OF BOULTON, WATT AND MURDOCK

Many of those witnessing the unveiling ceremony, which took place at Birmingham last Friday, September 14, 1956, must have deemed it particularly fitting that the first statue erected to Matthew Boulton in his native city should have depicted him as one of a group, the other members of which are James Watt and William Murdock. The figures—in bronze—are rather more than 9ft in height and by the inclusion of inscribed scrolls, the bronze tableau suggests that a technical problem is being discussed. Set up in front of the College of Commerce in Broad Street, this impressive group was unveiled by Sir Percy H. Mills, Bt., K.B.E., chairman of W. and T. Avery, Ltd., whose works occupy the site of the former Soho Foundry of Boulton and Watt. While Boulton's statue stands not far from the ground formerly occupied by his—and his father's—original place of business in Snow Hill, the two Scotsmen commemorated with him spent the greater part of their lives in Birmingham, where all three became united not only as colleagues and friends but as a team unique in the history of the engineering industry. Even in death they were not divided, since all three of them sleep within the Parish Church of St. Mary, Handsworth. Contemplating their statues in Broad Street, we shall remember that neither Boulton, Watt nor Murdock, was ever the recipient of a title of rank. Watt, it is true, modestly declined the offer of a baronetcy, in reference to which episode Dr. Dickinson remarks that "the coat of arms with the motto *ingenio et labore*, borne by the Watt family and displayed on many of the monuments erected to Watt's memory, was not assumed until 1826. We can imagine with what irony Watt would have rejected the idea of becoming armigerous!" Nevertheless, the inscription on his monument in Westminster Abbey tells how it was raised by "The King, his ministers, and many of the nobles and commoners of the realm." Watt has long been commemorated, in Birmingham, by a statue erected close beside the Town Hall. Boulton, while the memorial to him in Handsworth Church includes a bust by John Flaxman, had not hitherto been honoured by a statue. Calling attention to this omission, Dr. Dickinson—writing in 1936—expresses the hope that "the public spirit of its citizens will see to it that this defect shall not go much longer unremedied." The defect has now been made good by the ceremony at Birmingham on September 14th, and an inscription on the Portland stone base of the bronze group tells how "The conception of Richard Wheatley, a leather goods manufacturer of this city, coupled with his generosity and a contribution by the City Council, enabled these statues to be executed by William Bloye, Sculptor." The statue to Murdock (who was the junior of Boulton by twenty-six years) commemorates not only the gifted and faithful right-hand man of Boulton and Watt, but the founder, in a technical sense, of the gas industry, though his inventions in this field were not patented.

Contemplating the labours and achievements of Boulton, Watt and Murdock, we shall be impressed by the part played—in the history of these famous men—by imagination and industry. Meagre indeed was their research equipment, but each one of them possessed singular intuitive power joined with an infinite capacity for taking pains. They were also endowed with what is best called technical conscientiousness, a quality which influenced all their efforts. If anything gave way on a Boulton and Watt engine it was at once dealt with in such a manner as to remove, as far as possible, the hazard of any further trouble. Boulton, Watt and Murdock were aware, moreover, that the premonitory creak in human relations could be even more alarming than the premonitory creak in machinery. That is why the funeral of Matthew Boulton was followed, on foot, by the whole of the working force at Soho. We may dwell with advantage on the extent to which both Boulton and Watt maintained personal contact with their men, since to-day, as in their day, we have clamant need alike for leaders and for craftsmen. We have also the need for a true realisation of the value, in industrial relations, of those good manners which were so conspicuous an attribute in Mathew Boulton. We read how one who knew him intimately, hearing Boulton praised for his ability, remarked: "As to his ability, other persons can better judge. But I can say that he was the best-mannered man I ever knew." Engineers all over the world will rejoice to know of the tribute now rendered to the memory of an illustrious trio, the members of which surely belong to the society of those praised by an unknown author of the second century B.C., who tells us that:

"Without these cannot a city be inhabited: and they shall not dwell where they will, nor go up and down.... But they will maintain the state of the world, and their desire is in the work of their craft."

"THIS REALLY DISGUSTING PROCESS"

Do all highly specialised technologists eventually embed themselves in a deep rut of conservative thought? Does specialisation, after a time, lead to a diminishing of that critical power of discrimination of the wide principles which govern any particular technology? Why is it, then, that a student of another science can often cast a refreshingly new light on the specialist's own pet subject? That indeed was the case last week, when Mr. Sciver, a consulting chemist and bacteriologist, delivered his presidential address to the Institution of Public Health Engineers. Some of his suggestions were recorded in our Seven Day Journal last week. They inferred that significant improvements might be introduced into the process of sewage purification by such steps as the use of hydraulic models, which apparently is uncommon in this particular field, and the use of the centrifuge to replace sedimentation tanks.

Important though such improvements might be, it is even more important that such processes as are in use should be effective and comprehensive. Mr. Sciver drew attention to the lamentable state of pollution of many rivers and coastlines of this country. He was particularly emphatic about the discharge of crude sewage into the sea, a "really disgusting process," he affirmed, which went on all round our coasts. Under certain conditions of light, wind and tide, an opalescence or discoloration of the sea, due to pollution, could be seen along much of the coast and extending several miles out to sea. Much more could be done, Mr. Sciver affirmed, to improve conditions of pollution in rivers without undue hardship to local authorities or traders. He is indeed, to be commended for drawing attention to these inadequacies in the purification of trade and domestic wastes. The habitual sight of dirty rivers and coastal outfalls of crude sewage tends to dull the offence which they offer to our sensibilities. They become accepted as part of the order of things—and as Mr. Sciver points out, in a country which prides itself on its high standard of sanitation, and is contemptuous of the allegedly lower standards of the foreigner!

A Seven Day Journal

Engineering Education in Russia

LAST Sunday a party of nine British engineers left this country for Russia, where they are spending twelve days seeing some of the ways in which the U.S.S.R. is dealing with technical education and training. Dr. E. Giffen, M.I.Mech.E., Professor of Civil and Mechanical Engineering in the University of London, is the leader of the party, the other members of which are Mr. W. K. Brasher, M.I.E.E., Dr. B. N. Cole, A.M.I. Mech.E., Mr. H. E. Dance, M.I.Mech.E., Dr. H. I. Haslegrave, M.I.Mech.E., Mr. G. S. C. Lucas, M.I.E.E., Mr. P. E. Sleight, M.I.C.E., Mr. E. G. Sterland, A.M.I.Mech.E. and Professor A. S. T. Thomson, M.I.Mech.E. All of them are members of the joint advisory committee on education of the Institutions of Civil, Mechanical and Electrical Engineers, which has collaborated with the Soviet Relations Committee of the British Council in making arrangements for the visit. Before leaving, Dr. Giffen explained that the party would be visiting the State University in Moscow, the Higher Technical School, and the recently built Energetics Institute. It was also arranged that visits should be made to the Electrotechnical, Polytechnical and Construction Engineering Institutes in Leningrad. Estimates of the present yearly output of Russian graduates from these and other establishments throughout the country vary, but have been put as high as 140,000, against the comparable American figure of 75,000 and the British figure of 12,000. It has been stated, moreover, that experts agree that Russian graduate engineers are as well-grounded in fundamentals as their British and American counterparts.

The Traditions of Craftsmanship

MEMBERS of the council of the Association of Engineering Distributors, together with a number of guests, listened with considerable interest, last Tuesday, to an after-luncheon talk by the Master Cutler, Mr. R. P. Phillips. He spoke about the traditions of craftsmanship in industry to-day, basing his remarks on the long history of the Company of Cutlers in Hallamshire. Mr. Phillips said that throughout its history of over 300 years, the Cutlers Company had stood for all that was best in craftsmanship. He recalled that its affairs were controlled by a court consisting of the Master, two wardens, six "searchers" and twenty-five assistants, and pointed out that the function of the "searchers" was still the detection of bad workmanship. Mr. Phillips went on to say that, during his year of office as Master of the Cutlers Company, the thing that had most impressed itself upon him was that the value of craftsmanship must never be forgotten. He realised that it was not always easy to achieve a high standard of craftsmanship to-day, yet he was confident that it constituted a tradition that must be nurtured and maintained. In the coming period of automation, Mr. Phillips added, it was more than ever essential to retain pride in the high ideals represented by craftsmanship. The Master Cutler's final word was about what he termed the "pressing problem of production and distribution costs." He remarked that in the first six months of this year the index of rates of wages rose by eight points. Something must be done to hold costs of production, Mr. Phillips emphasised, in order that this country could remain competitive.

Cathodic Protection

A TALK on cathodic protection was given at the recent Old Centralians luncheon, held on September 14th at the Mapleton Restaurant in London. The speaker was Mr. H. G. B. Nolan; he gave an entertaining account, which included a résumé of the electro-chemical principles involved in cathodic protection, and the way they were applied in practice to protect buried pipelines and other metallic structures. He also commented upon some of his own experiences in launching a programme of the order of half a million pounds for a pipeline system, probably the largest cathodic protection scheme in the Eastern hemisphere. The history of the process had started over a hundred years ago in England, when Sir Humphry Davy had applied it to ships' hulls, with a sacrificial anode. Since then research workers in the United Kingdom, particularly at Cambridge and the Chemical Research Laboratories at Teddington, Mr. Nolan continued, had probably led the world. But the Americans had forged ahead in the large-scale application of the process, largely due to the nature of their oil industry. More recently, however, British applications had been developed, particularly by oil firms, principally overseas, and to some extent for protecting gas and water mains and G.P.O. cables. England was now in a strong position for carrying out such work, on a world-wide basis, he said, and there was one firm of purely professional consultants and three firms of engineering contractors who specialised in cathodic protection.

The Engineer
100 Years Ago
(SEPTEMBER 19, 1856)

"THE INSTITUTION OF MECHANICAL ENGINEERS"

"We hate fault-finding. We can bear much, and are willing to do so, without complaint . . . But the necessity for remonstrance becomes urgent at times, and when it may possibly prove useful we may not shirk a duty, even though irksome. At this time is being held in Glasgow, a meeting of engineers, men gathered from all parts of the Kingdom. In another column will be found a report of the very excellent speech of Mr. Whitworth, the President of the Institution, under whose auspices this gathering has been formed. A number of very interesting papers have been read before the assembly; to-day, perhaps at this very hour, a large party is exploring the various manufacturing establishments on the banks of the Clyde. This gathering has been anticipated for a considerable period, with much interest, by those who had any knowledge of the programme.

"Last week we gave a list of the papers intended to be read and discussed at the Glasgow meeting of the Institution of Mechanical Engineers. Doubtless our readers, if they supposed anything about it, at all, supposed that the list was sent to us for publication. Nothing of the kind. As far as we are concerned, officially speaking, we would have been as ignorant of the Glasgow meeting at this moment as if it had never been thought of! This is our cause for complaint. The officers of the Institution are as well aware as that the moon is in the heavens, that this Journal circulates by thousands amongst the very men to whom such information is of value. They see it in every establishment into which they enter, and they know right well that there is scarcely an engineer in these kingdoms, civil or vulgar, who does not peruse, or at least glance over, its columns. And yet such is their thoughtlessness, their want of tact, that not the slightest intimation is given us of their intention, not any facility afforded us for reports . . . There is a duty owing to the great body of engineers by which we are supported, and it is upon its behalf that we demand that some proper attention be paid in matters such as these. The great chartered societies of the metropolis consider it politic and respectful that the Press shall always be informed of their proceedings and intended proceedings; and we do not see any reason why the New Hall-street Institution should not 'take heart of grace' and follow in their wake, however great the distance. *Verb. sap. sat.*"

Coal Statistics

THE quarterly statistical statement published yesterday by the National Coal Board shows that, for the second quarter of this year, an estimated surplus of £1,678,186 was achieved. During the quarter the saleable quantity of coal from the Board's mines was 52,802,457 tons, the amount "disposable commercially" being 49,564,427 tons. The total costs of coal production were £193,940,277 and the proceeds of sales came to £198,667,463, so that the actual trading profit, before charging interest, was £4,727,186. The estimated profit on opencast working was £2,530,000 and on ancillary undertakings, £946,000, thus making the Board's estimated total profit for the quarter £8,203,186. Provision for taxation and other items is put at £525,000, and the interest payable to the Minister of Fuel and Power is shown as £6,000,000. When these amounts, therefore, are deducted from the figure shown as profit, the surplus amounts to the £1,678,186 already mentioned. The statement indicates that, in the second quarter, the estimated loss on imported coal was £4,985,000, but it is recalled that "since recent general increases in coal prices are partly intended to recoup the loss on imported coal, the loss has been met by an appropriation from the proceeds of sale of British coal."

Mr. A. M. Low

WE record with regret the death of Mr. Archibald Montgomery Low, which occurred at his home in London on September 13th, at the age of sixty-eight. Through his many inventions and popular scientific writing he was known to a large company of people, both technical and lay. A. M. Low was educated at St. Paul's School and at the Imperial College of Science and Technology, and as a young man was concerned with the invention of various motor car accessories, and of a system of radio signalling. When the first world war started, Mr. Low joined the R.N.V.R. and subsequently transferred to the Royal Air Force where he served as an experimental officer. His inventions during the war and in the years that followed included radio torpedo control gear and apparatus concerned with several aspects of noise measurement and abatement. A. M. Low's most prolific years as a science writer were undoubtedly those between the wars, and the list of his published works is an impressive one. His activities in the realm of science and technology were many, and among them was his work for the Institute of Patentees, of which he was the president: he was also president of the British Institute of Engineering Technology. He had been chairman of the Auto-Cycle Union since 1932 continuously.

Commercial Motor Show

No. I

THIS autumn Earls Court, London, again becomes the focal point of interest for all concerned with the varied products of the motor industry.

Three events in close sequence—the Commercial Motor Show, the Motor Show, and the Motor Cycle Show—afford an unequalled opportunity for the general public, as well as for traders at home and abroad, to view under one roof many of the world's leading motor vehicles and allied products.

The first of these events, the Commercial Motor Show, is being opened to-day, Friday, September 21st, by Mr. Peter Thorneycroft, President of the Board of Trade. The show, which is organised biennially by the Society of Motor Manufacturers and Traders, is the eighteenth of its kind since the commencement of the series in 1907, and occupies 275,000 square feet, the greatest display area of any show ever organised by the Society. There are over 440 stands and, in the vehicle section alone, forty manufacturers (among them two German, two Czecho-Slovakian, one Dutch and one Swedish firms), are showing their products, ranging from dual-purpose cars, small delivery vans and taxis, up to heavy lorries and buses. An additional attraction to the show will be a demonstration, jointly organised by the Ministry of Supply and the S.M.M.T., of military vehicles at the Fighting Vehicle Research and Development Establishment at Chertsey.

It is obvious that a display of commercial vehicles is likely to attract the general public to a less extent than the Motor Show, which will take place a month later. The high paid-admission figures of the post-war commercial motor shows, however, clearly indicate that there are thousands of technically minded people who consider these exhibitions an excellent opportunity of studying modern automobile design in detail and undisturbed by the crowds which throng the stands at the motor-car shows.

The economic position of the British industry making commercial vehicles has been quite satisfactory in the years after the war, and it seems that this situation is likely to remain. Output has risen from 242,400 units in 1952 to 340,800 in 1955, i.e. by about 40 per cent, and, according to the latest statistics, has continued to increase in the current year. Output is now running at roughly three and a half times that of the best pre-war year, 1938, an expansion which is proportionally greater than that of the motor-car industry. Exports in 1955 amounting to 158,000 vehicles, increased by 25 per cent, compared to 1954, though the total of exports has not considerably altered since 1950, in which year a record number of 165,000 vehicles was shipped abroad.

By far the greatest number of vehicles made last year, namely 188,400, equivalent to 55 per cent of the total output, were dual-purpose cars, pick-ups and delivery vans with a carrying capacity up to 15 cwt. Their percentage relative to the total production has risen sharply in the last five years, and, in the first months of this year, was nearly double what it was the opening months of 1952.

In contrast to the trend of output for light vehicles the production of medium trucks up to 6 tons carrying capacity in 1955 was only slightly higher than it was four years ago ; it amounted to 118,000 units, i.e. to 34 per cent of the total production, compared to 46 per cent in 1952.

On the other hand, the output of heavy vehicles of more than 6 tons load has increased considerably and is now more than twice what it was four years ago ; 24,200 heavy goods vehicles and 9600 buses, accounting for 10 per cent of the total production, were made in 1955—about 20 per cent more than in 1954—and it can be assumed that by far the greatest part of these vehicles was shipped abroad.

It has already been mentioned that the volume of overseas sales of commercial vehicles has remained practically constant since 1950, so that the increased production of the last years was almost entirely absorbed by the home market. Nevertheless, the industry has made a substantial contribution to exports. Last year 158,000 vehicles, i.e. 46 per cent of the total production, were sold abroad, earning the equivalent of £87,000,000 in foreign currency. Although 70 per cent of these exports went to the Irish Republic and to Commonwealth countries, there is every indication that British firms are well able to hold their position in free competitive markets, especially in the field of heavy goods and public service vehicles. Their versatility and readiness to accept new ideas, in contrast to the more conservative attitude of the motor-car industry, is mainly responsible for British exports being second only to those of U.S.A., which last year sold 192,000 commercial vehicles abroad, and considerably higher than the German exports (amounting to 85,000 units).

On the home market the demand for commercial vehicles has been less affected by the anti-inflationary measures imposed by the Government than was originally anticipated. Contrary to the conditions prevailing in the motor-car industry, the output has not only remained remarkably steady, but, in the case of some popular makes, has even increased in recent months. It is generally believed that the potential home market for commercial vehicles is still expansive and will continue to remain so for some time, the more so as there are a great number of antiquated vehicles in operation which are hardly road-worthy and will require early replacement. In these circumstances, the future outlook for the commercial vehicle industry can be regarded with optimism.

Turning now to the Commercial Motor Show itself, we must state that the short time available between the preview and this first report going to press, makes it impossible to give more than an account of our first impressions and a short survey of the trends incorporated in some prominent exhibits. In view of the heterogeneous character of commercial vehicles which differ so considerably in size, weight and purpose it is, of course, difficult to discern a clearly defined tendency which might be applicable to their general constructional layout. The trend at this year's show is roughly the same as that already apparent on the occasions of the two previous post-war exhibitions, and can again be summarised under the headings of increased economy and safety. The constructional means of materialising these requirements are well known and have already been practised for some time. As far as economy is concerned they comprise the increased application of diesel engines for vehicles of the ¾-ton to 2-ton range and, further, the construction of lighter chassis and bodies for the purpose of improving the ratio of unladen weight to payload without sacrificing strength. With regard to safety, considerable care has been taken to improve the driver's comfort, thus reducing fatigue and accidents resulting therefrom, by better interior fittings, heating and ventilation, and by sensible arrangement of the instruments. In the heavier class of goods vehicles great efforts have been made to facilitate the operation of the gear change—with the ultimate aim of eliminating the clutch altogether—and to assist braking and, in some cases, steering by servo mechanisms. Similar trends also apply to public service passenger vehicles, in which the designers are now readily adopting constructional features so far mainly confined to motor-car design. Integral body-cum-chassis constructions, fully automatic transmissions, independent front wheel suspensions and coil-spring or torsion bar arrangements are coming into use, and have already proved their value in improving the handling and riding properties of buses and coaches with a corresponding gain in passenger comfort. Another development in

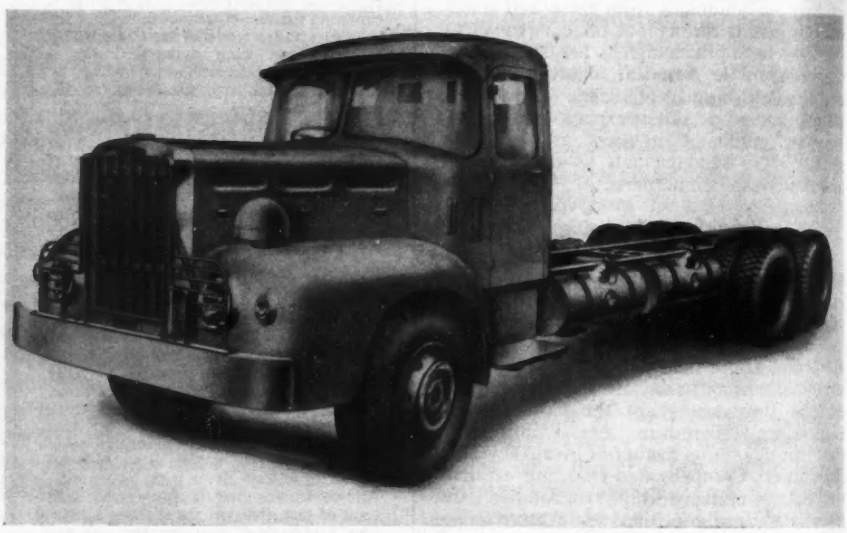

Fig. 1—The Leyland "Buffalo" is intended for fast trucking in rarefied atmospheres

this field is the introduction of small buses seating from eight to twelve passengers (frequently up to twenty schoolchildren) with adequate comfort. Those vehicles have already become popular on the Continent where they have been employed for some time as school and hotel buses or whenever a small volume of traffic does not justify larger vehicles.

From this generalised summary it may be concluded that the greater part of the vehicles at this show differ only in detail from those seen previously either at Earls Court or at more recent International exhibitions; their constructional layout is more or less conventional, and no startling changes in design are apparent. Such a development is more

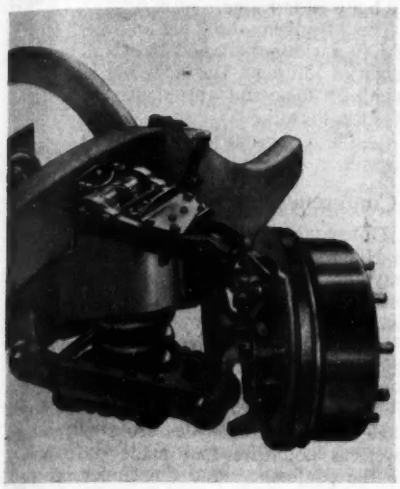

Fig. 2—Front suspension of the "Bridgemaster"

or less natural in an industry where the basic design is not so much affected by trends of fashion or by the desire of individual manufacturers to gain additional selling points, as by the functional suitability of the product. As to the latter point, British commercial vehicles have proved themselves so satisfactory at home and overseas under the most severe operating conditions, for there to be no urgent technical or economic need for major changes of sound designs. On the other hand, there are hardly any models at the show which have not undergone that steady process of refinement and improvement which continues almost unnoticed as long as one particular type is being produced. Some chassis of heavy goods and passenger vehicles in particular show considerable ingenuity in the detail design of major components and accessories, and their study alone should make a visit to the Commercial Show worth while to everyone interested in motor engineering.

It is obvious that public attention will mainly centre on the biggest and most spectacular exhibits of the Show. Among these there is at the stand of Leyland Motors, Ltd., the large bonnet-type six-wheeler "Buffalo," seen in Fig. 1, a haulage model with a 22ft wheelbase, designed for a gross vehicle weight of 25 tons and a gross train weight of 45 tons. It has an overall length of 35ft and is also available as a tractor.

In general design the "Buffalo" is a larger version of the six-wheeled Leyland "Super Hippo" range of trucks; its main features are a 200 h.p. diesel engine, power-assisted steering, independent braking system for the front wheels and the bogie wheels, and an eight-speed "Pneumo-Cyclic" semi-automatic gearbox with remote control.

The 15·2-litre, six-cylinder engine of 139·7mm bore and 165mm stroke develops 200 h.p. at 1800 r.p.m. with a maximum torque of 658 lb-ft at 1000 r.p.m. It has wet cylinder liners, but in other respects is similar to other Leyland engines.

The engine torque is transmitted via a 20in diameter fluid coupling to the eight-speed gearbox which is a direct air-shift semi-automatic unit developed from the four-speed gearbox. The forward portion of the gearbox contains four forward and one reverse ratios which, when compounded with the two epicyclic gear trains in the rear portion, give eight forward and two reverse speeds.

Gear changes are made by moving a lever on the controller mounted on the steering column, the admission of air to the operating cylinders of the gearbox being controlled by electro-magnetic valves. The control lever works on the ratchet principle and is spring-loaded so that it always returns to the central position. Each time the lever is moved forward a gear one higher is selected, while moving it backward engages the next lower gear: the gear engaged is indicated by a pointer on an illuminated dial.

Transmission to the rear bogie is effected by an open propeller shaft. The two rear axles are coupled by a short universally jointed shaft through a third differential incorporating a locking device. Each axle is fully floating with an overhead worm drive, and is attached to the ends of inverted semi-elliptic springs which are located at their centres to trunnion-bearing housings bolted to the chassis members.

The front axle follows normal Leyland practice for heavy goods vehicles, but the 4in wide front springs are of the progressive type. Hydraulic power-assisted steering is provided as standard equipment.

Cam-operated air brakes are used for all wheels, the brake pedal being coupled directly to a dual control valve which connects to separate air reservoirs for the front and for the bogie wheels. An exhaust brake can be fitted if required.

The three-man cab has a two-piece wrap-round windscreen with a thin centre pillar, and is of double-skin metal construction, thus providing good insulation in varying climatic conditions.

Another interesting exhibit at the Leyland stand is a forty-seater coach, illustrated in Fig. 4, the body of which has been designed by the well-known Italian stylist Ghia. Unusually wide-angle vision for the passengers is given by the almost unbroken sweep of four large windows. A polished metal side belt extends round the lower part of the front overhang and incorporates the bumpers and the air intake of the radiator. The body, 36ft long and 8ft wide, sweeps back in an almost unbroken line from front to rear, terminating in attractive tail fins which carry the stop and directional lights. Neatly incorporated in the overall styling is an air scoop, extending over almost the full length of the roof, which provides clean air for ventilation.

This modern body is mounted on a "Worldmaster" chassis, fitted with a 150 h.p., six-cylinder, underfloor diesel engine and a semi-automatic "Pneumo-Cyclic" five-speed gearbox.

Powerful emergency braking or smooth retardation, at will, is effected by a double-pressure pedal control. Light pedal pressure releases air progressively for normal braking; a full flow of air for emergency stops is provided by additional pressure against an adjustable spring-loaded buffer. To ensure equal braking, each wheel has its own diaphragm-operated brake chamber.

Another Leyland exhibit, the "Atlantean" low-height, double-deck bus with front entrance and transversely mounted rear engine, has been fully described in THE ENGINEER of September 7, 1956. Quite apart from the general conception and the well-devised detail design of this vehicle, it is interesting to note that British manufacturers of heavy passenger vehicles, after their all-too-ready adoption of the underfloor engine, are evidently showing some renewed interest in the other alternative for better space utilisation, namely, the rear-mounted engine. The advantages claimed in favour of the rear-mounted engine, compared to the underfloor engine, are the greater accessibility of the power unit and the fact that the floor can be kept low without impairing the ground clearance. It must be admitted that the protagonists of the rear-engine drive have a good case, and it should be remembered that rear-engine coaches are being extensively and successfully used in the U.S.A., and on the Continent. One of the formerly existing difficulties, the operation of gear change and engine controls from the driver's seat, has been overcome by modern methods of remote control.

The A.C.V. group of companies, comprising the firms of A.E.C., Crossley, Maudslay, and two body-builders, is exhibiting many types of vehicles, the passenger range including single-deckers and double-deckers, both with vertical and underfloor engines. The goods models shown are home and overseas

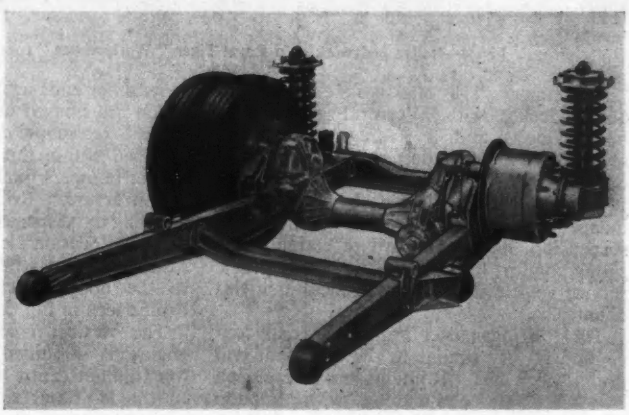

Fig. 3—Rear suspension of the "Bridgemaster," showing the trailing arms flexibly mounted on the axle

versions of the four and six-wheeled designs.

The 12-ton gross medium weight "Mercury" chassis has now been superseded by the Mark II version, permitting the operator to take advantage of the 14-ton gross weight legal maximum; in spite of the stronger design of frame, front and rear axles, and brakes, the chassis is only slightly heavier than its predecessor. Closely related to the "Mercury" Mark II is the "Mustang" Mark II, which incorporates practically the same basic components in a

twin-steering, six-wheel form giving a gross load capacity of 18 tons, with a chassis and cab weight of less than 5 tons. All "Mercury" and "Mustang" vehicles are fitted with 7·68-litre engines with an output of 112 h.p. at 2000 r.p.m. Among the heavy goods vehicles there is a "Mammoth" Mark III tractor chassis and a "Mammoth Major" load carrier, both being examples of a new range of chassis designed to cater for markets where bonneted chassis are preferred. Both four and six-wheel chassis are offered in two wheelbases, and all use the 11·6-litre engine and a five or six-speed, constant-mesh gearbox. The three-axle chassis is normally fitted with an articulated bogie with overhead worm drive and a third differential, but for exceptionally severe operating conditions a double-reduction type of rear bogie can be supplied. Amongst other equipment, which can optionally be fitted, are hydraulic power assistance for steering, two-speed auxiliary gearbox, and an oil cooler incorporated in the large-capacity radiator.

An interesting exhibit in the A.C.V. range of passenger vehicles is the Crossley

Fig. 4—Italian bodywork on a Royal Tiger "Worldmaster" coach seating forty

"Bridgemaster," a chassisless light-weight double-decker with a central gangway in both saloons and a seating capacity for seventy-two people, designed for operation on roads where the overall height is restricted. It is claimed that this bus, by virtue of its independent front and coil spring rear suspension, has a standard of stability and riding comfort far ahead of any other public service vehicle in regular production in this country.

The "Bridgemaster" in its general conception is very similar to the sixty-four-seat double-deck bus "Routemaster," developed by A.E.C. in conjunction with London Transport Executive, the prototype of which was first shown at the Commercial Motor Show, 1954.

The body consists of a rigid box-like structure formed by the underframe, the side pillars and panels, the roof and the front and rear bulkheads. The front bulkhead carries the driver's cab and such front near-side units as the wing, bonnet and front cowling, while the rear platform structure and the staircase are suspended from the upper saloon. All the frame members, pillars, roof bearers and the stressed panels are made from high-duty aluminium alloy. The underframe is constructed of channel-section longitudinal and cross members; the ⅛in thick aluminium flooring is riveted to the top flanges, and corner gussets to the bottom flanges, thus forming a stiff box-shaped floor structure of considerable torsional stiffness.

The front sub-frame, built up from pressed steel channel-section length and cross members, carries the engine gearbox unit, the front suspension, radiator, steering and the controls. It is attached by bolts to the body underframe, which is suitably reinforced at the mounting points. The independent suspension (Fig. 2) employs wishbones of unequal length and coil springs concentric with direct-acting telescopic dampers, and the worm-and-nut type steering box is mounted at the front cross member.

The rear suspension, locating the double-reduction rear axle on rubber mountings, is also built up from pressed steel channel sections; it consists of two trailing arms which are pivoted at their front ends on rubber bushes from brackets mounted at the body floor structure. These arms are tied together by two cross members, one ahead of and the other behind the axle assembly. The rear cross member extends across almost the whole width of the vehicle and reacts at its outer ends against the rear coil springs which are housed at the rear of the wheel-boxes. Telescopic direct-acting dampers are enclosed within the springs and progressive rubber bumpers limit the travel of the swinging structure. Roll is accommodated by allowing the suspension members to "weave." Lateral location is by a transverse rod extending from a bracket on the axle casing to the body structure. The arrangement can be seen in Fig. 3.

The vertical 7·68-litre, six-cylinder diesel engine is mounted at the sub-frame, its longitudinal centre line being slightly offset to the left-hand side of the vehicle. The engine torque is transmitted through a hydraulically-operated, single-plate clutch to a four-speed synchronised gearbox attached to the flywheel housing of the engine; a transfer box, incorporating two helical spur gears, is bolted to the rear of the gearbox to provide an offset drive to the rear axle. The propeller shaft consists of three parts, the front and rear shafts having needle bearing universal joints at either end, while the short intermediate shaft is carried in two bearings located from the floor structure of the vehicle.

The rear axle assembly comprises reduction gear cases at each side, joined together by a weldless steel centre tube which is situated below the wheel centres to cater for the low floor level. The left-hand reduction gear casing is cast integral with the casing of the primary drive, which comprises a spiral bevel gear and a four-star differential. The differential drives to the wheel hub on its own side through two spur gears and to the opposite one through similar gearing from a shaft running through the centre tube of the axle assembly. The primary reduction ratio is 1·88 : 1 and the secondary ratio 3·295, giving a total reduction of 6·19 : 1.

The brakes are air-controlled, hydraulically operated at the front and pneumatic at the rear. The rear brake cylinders are of the diaphragm type, mounted on the radius arms of the rear suspension frame. Air pressure is supplied from an engine mounted compressor which feeds a reservoir mounted on the body underframe.

The "Bridgemaster" has an overall length of 30ft, a width of 8ft, and an overall unladen height of 13ft 6in. The laden bus has a floor heigth of 20½in and an unladen kerb weight of 7 ton 17cwt.

(To be continued)

Conference on Urban Motorways

DURING this week, on Tuesday, Wednesday and Thursday, a conference on urban motorways was in progress in London at the Friends House, Euston Road. The conference was organised by the British Road Federation, and was international in character and scope. At the opening of the conference on Tuesday, Lord Derwent, chairman of the Federation, made a speech in which he noted that about 100 delegates from thirty-three overseas countries had made the journey to the conference, and the conference roll, which included fifteen members of parliament and two hundred aldermen, was a certain sign of the growing concern about the traffic predicament. Fast, direct cross country routes, Lord Derwent continued, would not by themselves allow the best to be got out of road vehicles; they ought to be carried into the heart of urban areas but in doing so special problems had to be solved. In Britain 75 per cent of road accidents occurred in built up areas, he went on, where there were too many vehicles, pedestrians and cyclists in towns and cities largely unaltered since the advent of the motor vehicle. A logical way to end the conflict was to segregate the different road users, and to take the traffic out of the way of pedestrians. The skills of the architects, planners and engineers of to-day, he asserted, could be relied on to design for beauty in constructing such urban motor routes.

The British approach to urban motorways, with an explanation of their advantages and functions, was given in the paper presented by Messrs. W. H. Glanville and J. F. A. Baker entitled, "Urban Motorways in Great Britain?" which was discussed on Tuesday afternoon. The director of roads of the Netherlands Government, Ing. M. le C. de Bussy, presented a paper on "The Need for Urban Motorways," and Mr. A. S. Hodgkiss of the Triborough Bridge and Tunnel Authority, New York, contributed "The economic justification of urban motorways." These two papers were discussed on Wednesday. The final day of the conference was taken up principally in discussing the paper, "Some design aspects of urban motorways" by Dr. M. E. Feuchtinger, a German traffic engineering consultant, and in open discussion of urban motorway practice. A considerable number of written contributions were received relating to this discussion which were reproduced for the conference in two supplements.

Bicentenary of John Loudon MacAdam, 1756-1836

(Contributed)

MANY of the details given in biographies of the life of John Loudon MacAdam are not supported by contemporary eighteenth century records. Thus, there is no confirmation in the Admiralty archives that he ever had any official appointment, only that he was a merchant paid a commission, usually 10 per cent, for selling naval prizes. There is even a doubt about the date of his birth. His tombstone gives it as September 21, 1756. The parochial register of Ayr gives it as September 23rd. Any future biographer of him could not do better than consult the thesis on his life by which Professor Harry Spiro Junior, of Clinton College, Clinton, Mississippi, gained the degree of Ph.D. of Edinburgh University in 1950. (92 Mac. 62586.) Professor Spiro's knowledge of eighteenth century documents is remarkable, and he is accurate, erudite and thorough.

The surprising thing about MacAdam was that he was a merchant until he was sixty, then, to borrow a religious phrase, he became a highway engineer "by conviction" and preached and taught his "system" up and down the country until he became known to everyone as "the colossus of roads." Like many another preacher he was often unpaid. Between his sixtieth and sixty-seventh years he personally attended on the officials of seventy turnpike trusts to advise them, making no charges. "If I had not sent answers to enquiries saying I would go gratuitously I believe I should not have been consulted," he says. "If I had made it a money-making speculation my system never would have been introduced into the country at all." Parliament gave him a grant but this was later.

MacAdam's father died when he was fourteen, and he went to New York to join his uncle, who was in business there as a general merchant and auctioneer. Throughout the rebellion of the colonists he was a "loyalist," and when the United States became independent in 1783, he returned to Scotland, where he modernised a coal mine and sold coke, tar and varnish. He went to Falmouth in 1798, where he sold a naval prize taken from the French, and then he went to Bristol. For a wealthy merchant as he had then become, there is a hint that he was in straitened circumstances for a time because, although in 1805 he petitioned to be a Freeman of Bristol, Professor Spiro finds that he did not pay the dues to have his name placed on the roll. He may not have been prosperous but he was certainly prominent, because in 1816 he led the agitation to rebuild Bristol gaol that had been condemned by John Howard, the great prison reformer.

In the same year he became inspector for the Bristol Turnpike trust. Their roads were bad and the trust was in debt. In a few years the roads were among the best in the kingdom and the debt had been reduced. He repaired them by "lifting." Let us describe the process in his own words. "No addition of materials is to be brought upon a road unless in any part of it be found that there is not a quantity of clean stone equal to ten inches in thickness. The stone already in the road is to be loosened up and broken, so as no piece shall exceed six ounces in weight. The road is then to be laid as flat as possible, a rise of 3in from the centre to the side is sufficient for a road 30ft wide. The stones when loosened in the road are to be gathered off by means of a strong, heavy rake with teeth 2½in in length to the side of the road and there broken and on no account are stones to be broken on the road. When the great stones have been removed and none left in the road exceeding 6 oz the road is to be put in shape and a rake employed to smooth the surface, which will at the same time lay to the surface the remaining stone and will allow the dirt to go down. When the road is so prepared the stone that has been broken by the side of the road is then to be carefully spread on it—this is rather a nice operation and the future quality of the road will greatly depend on the manner in which it is performed. The stone must not be laid on in shovels full but scattered over the surface, one shovel full following another and spreading over a considerable space."

Sometimes a layer of "quarry wastes" was spread on the road bed before the hand-broken stone. MacAdam made the traffic provide the compaction, adding stone only where it was needed. He insisted on dry stone laid accurately to the specified cross fall. He says "Carriages, whatever be the construction of their wheels, will make ruts in a new made road until it consolidates, however well the materials may be prepared or however judiciously applied; therefore, a careful person must attend for some time after the road is opened for use to rake in the track made by wheels." "Every road is to be made of broken stone without mixture of earth, chalk, clay or any other matter that will imbibe water and be affected with frost. Nothing is to be added on the clean stone on pretence of binding, broken stone will combine by its own angles into a smooth, solid surface that cannot be affected by vicissitudes of weather or displaced by the action of wheels which will pass over it without a jolt and consequently without injury."

Again, a reflection of the times: "The only proper method of breaking stones both for effect and economy, is by persons sitting; the stones are to be placed in small heaps, and women, boys or old men past hard work must sit down with small hammers and break them so as none shall exceed 6 oz in weight." He even specifies the hammers. "Small hammers of about 1 lb in weight in the head, the face the size of a new shilling, well-steeled with a short handle."

There is something of the man in his prose style; he insisted always upon "carefully phrased and specific instructions for all contractors and subordinates," and part of our debt to him may well be that he helped to bring order and method and clarity into road building. One great characteristic about MacAdam was that he gave reasons why a thing should be done in such a way that his men felt they understood what they were doing. He explained carefully that a road must be very level otherwise the labour of the horses is spent in lifting the carriage on to a stone which is proud, which then crushes under the weight and leaves a wound in the road. "Road materials do not wear out; they are displaced by the action of carriages on stones of too large a size which are jolted out or joltingly surmounted." "In either case, the road is injured and the injury will be greater in the exact proportion of the number and size of the obstacles. But a carriage of any construction of wheels, or body or weight will pass over a smooth surface without injury to that surface." He even tried to explain why his stones should be the size he recommended; they "must be in due proportion to the space occupied by a wheel of ordinary dimensions on a smooth level surface, this point of contact will be found longitudinally to be about 1in, and every piece of stone put into a road which exceeds an inch in any of its dimensions is mischievous."

Part of his success as an engineer was that he laid great emphasis on drainage; his lengthsmen had to keep their ditches clean and their watercourses free running. He wrote this: "The thickness of a road is immaterial as to its strength for carrying weight. This object is already attained by providing a dry surface over which the road is to be placed as a covering or roof in order to preserve it in that state; experience having shown that if water passes through and fills the native soil, the road, whatever may be its thickness, loses its support and goes to pieces." In 1824 he was called to act as surveyor to the Carse of Gowrie turnpike road in Perthshire; he found that the road was on clay and had been formed by digging a trench and filling it with large stones; he ascribed the bad condition of the road to lack of drainage and cured it by lifting the road and draining the bed.

Another part of highway engineers' debt to MacAdam is that he helped to lay down the moral foundations of their profession. MacAdam's long business training in the organisation of enterprises of considerable size made him see that the age was one in which the intelligent amateur was being replaced by the trained professional specialist; among other professions that of the road engineer was beginning to emerge. He must be diligent and competent and proper records and accounts must be kept. MacAdam is writing about the duties of an "executive officer" or "general surveyor to a Turnpike Trust"; "In a trust of any extent, say about 150 miles of road, the time of such an officer would be very fully employed. He must direct the execution of the repairs and alterations of the road when ordered by the Commissioners and he must control the contracts and other agreements entered into by the sub-surveyors, so as to prevent unnecessary expense, he must examine all work performed to see that it is corresponding with contracts and generally keep a vigilant superintendence over the persons employed under him. Accounts of all expenses incurred should every second week be delivered by the sub-surveyors into his office in duplicate, after examination one copy to remain in the office, the other, certified to be sent to the Treasurer upon which payment may follow."

Writing about trust funds he says "much abuse exists in the expenditure partly from ignorance, but much more from peculation and patronage, very much misplaced. Under such circumstances the protection of the funds would be promoted by the inspection and control of a superior officer; and finally it might be desirable that a report from each trust should be made to Parliament of the receipt and expenditure of the year."

Was MacAdam the originator of the methods he described? His system is very similar to that of Tresaguet, who died when

MacAdam was forty, and there was much coming and going between Scotland and France; he always examined carefully other people's roads—he records that he was very struck with the great road through Kendal, in Westmorland, whose condition was very good, though no one knew who laid it. This question must be left open. In 1811 he wrote: "I propose to do what never yet has been done, to consider the making, the form and surface of roads scientifically." His writings make this claim good.

Parking in the U.S.A.

By H. J. H. STARKS, B.Sc., Ph.D., D.I.C., F.Inst.P*.

No. II—(*Concluded from page 359, September 14th*)

The rapidly increasing number of vehicles in use in the United States of America is creating serious parking difficulties in many cities. One of the consequences is the development of suburban shopping centres, and this is having serious repercussions on the commercial activities of the central business areas. To counteract these trends and to meet the insistent demands for more parking accommodation, some cities are making great efforts to solve their parking problems. This article considers the parking problems in American cities and describes some measures directed towards their solution. These include the use of parking meters for street parking, off-street parking sites, multi-storey open-deck garages with ramps or hoists for inter-floor movement, large underground car parks, mechanical parking of cars, car storage on the roof or upper floors or in the interior of buildings, and fringe parking. Information is given on the costs of providing these facilities, on the charges made for parking and on the methods used for enforcing the parking regulations.

Parking Garages

BECAUSE of their more permanent nature and the greater investment required for parking garages compared with parking lots, much more attention has to be paid to the design and operation of the garage. The structural design and architectural features of parking garages generally follow accepted practice; the location of the garage, its internal design and the operation of the terminal facilities, have been developed in recent years by applying the methods used in controlling traffic in the streets. The basis of the design for new parking garages is described by Ricker[7] and by the Portland Cement Association.[8]

Parking garages fall into two general classes—enclosed garages, including underground parks, and "open-deck" garages. The former is an enclosed structure usually with means of heating, lighting and ventilation. If there is more than one floor, lifts or ramps are provided for inter-floor travel. The open-deck garage (Figs. 12–16) consists of one or more floors with outside walls, and there is no provision for heating or ventilation. Apart from underground garages, few enclosed garages have been built in recent years. This is mainly because of the greater cost of construction and operation and because American cars have weather-resisting finishes. Most open-deck garages have ramps for inter-floor travel, and many ramp designs may be seen for facilitating movement and making most use of the space. Ramps are generally preferred to elevators.

There are a few so-called mechanical garages (Figs. 17–19) in which cars are parked by automatically-operated hoists; these require less space per car, no manœuvring space and few attendants, and cars can be parked or delivered quickly. The initial costs are somewhat higher but recent improvements in design and cost may make this class of garage a better proposition in central business or other congested areas.

Where land is expensive or is not available, off-street parking may be provided in underground parks.[9,10] It has generally been believed that the cost of excavation, drainage, water-proofing and the need to provide forced ventilation and extra lighting is prohibitive. The financial success of the Union Square Garage in San Francisco, opened in 1942, has done much to upset this belief and other large underground garages have been, or are being, built. The underground City Park Garage in Los Angeles holds about 2000 cars on three floors and the Grant Park Garage in Chicago has a maximum capacity of 2300 cars.

In the business districts of cities, there is an increasing tendency to provide garages on the same site as office buildings either underground (for example, the Grant Building in Pittsburgh has five floors of underground parking for tenants of the building), or within the building itself (for example, the Cafritz Building in Washington has a nine-floor internal garage with ramps, the offices being situated round the garage). Parking space is also provided on the flat roofs or upper floors of buildings, the office or shop occupying the lower floors.

The internal design of parking garages as regards stall sizes and manœuvring spaces has, of course, to be based on the characteristics of vehicles such as their length, width and turning circle. These features are liable to change and present a problem in the design of the garage if allowance is to be made for possible future changes. In some instances parking garages built in the late thirties to accommodate cars then being made are now no longer able to take as many cars because of increases in the overall length and width of present-day cars; one garage was seen in which the capacity was now 30 per cent below that originally planned; this made operation uneconomic and the garage was being demolished. The high gear ratio of the steering of all American cars and the fact that many cars now have power steering enables them to be manœuvred easily in confined spaces. Also many American cars have automatic transmission or special hill-holding devices which greatly facilitate operation on the ramps of parking garages, many of which have a slope of 1 in 8.

Costs of Parking Facilities

It is difficult to compare the costs of construction or operation of different classes of parking facilities because of differences in the cost of labour, in the kind of service rendered, in taxation, &c. Excluding land costs, the costs per car space for the enclosed garage is now about 1500 dollars to 2000 dollars, for open-deck garages about 300 dollars to 600 dollars, and for the latest kind of mechanical garage about 1100 dollars. The actual total cost of some off-street parking facilities in the business areas of a few cities is given in the table on page 397.

The energetic manner in which some cities are tackling their parking problems is illustrated by the figures given for Chicago in the table. Parking accommodation for an extra 12,000 cars has been provided in the last two years. This has been financed by the issue of revenue bonds for about 30,000,000 dollars, the bonds being redeemed from the

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Fig. 12—Open-deck garage, Washington, D.C.

Fig. 13—Open-deck garage in St. Louis, Mo.

Fig. 14—Open-deck garage in Pittsburgh, Pa.

Fig. 15—Open-deck garage under construction in Chicago

payments made by users. In some of the garages mentioned in the table the turnover of cars during business hours is about one-third of the capacity per hour.

It is found that if the overall cost of the garage plus land exceeds a figure of about 7 dollars per square foot it is more economical to have attendant parking than parking by customers, because the saving in car space obtained by closer parking by attendants more than offsets the added labour costs. Other factors have to be considered in deciding whether attendant or customer parking shall be adopted, and the general practice in most American cities now seems increasingly in favour of attendant parking. In suburban areas customer parking is usual.

Charges for Parking

The charges made for off-street parking are usually much higher in the business area of cities than outside it. The scale of charges in the smaller cities and towns is also lower than in large cities. The charges are dependent to some extent on the price drivers are prepared to pay for the convenience of parking close to their business premises or destination. Surveys have been made in several cities in an attempt to study the habits of drivers, particularly as regards the prices they will pay and the distances they will walk to obtain cheaper parking.[11,12] The results of these surveys vary considerably but in general it appears that drivers in large cities are prepared to pay from 1 dollar to 2 dollars for a whole day's parking (i.e. during normal business hours) or 50 cents for one hour and from 10 cents to 25 cents for each additional hour (up to a maximum of 1–2 dollars), provided they can park within about one block (220 yards) of their destination. Drivers seem prepared to walk up to as much as six blocks (¼ mile) if the parking fee is about 50 cents per day. In some cities drivers will walk up to six to eight blocks to park free of charge (e.g., in a residential street where there happens to be no restriction on the period of parking).

The charge in large cities for off-street parking in open lots or in garages in the business district is usually about 50 cents for the first hour and from 15–25 cents for each additional hour or part thereof, with a maximum fee of 1–2 dollars for a whole day's parking. The fees for night parking are usually at a lower rate than for parking during the day. For the driver who parks regularly off the street in the business district the annual average cost of parking is about the same as the annual average cost of petrol, insurance and taxes combined. In

Cost of Some Off-Street Parking Facilities in the Business Areas of American Cities

Location	Total cost, '000s of dollars	Number of car spaces	Number of levels		Cost per car space (dollars)	Land per car space (sq. ft)
			Above ground	Below ground		
"Open-deck" garages :						
Chicago (3·6)*	1683	1230	4	1	1368	69
	1027	665	4	—	1544	78
	1300	1000	5	—	1300	66
	1842	1206	4	—	1527	109
	1084	650	8	—	1668	65
Pittsburgh (0·7)	746	528	5+roof	—	1462	52
	1504	812	4+roof	1	1852	48
	1818	865	7	—	2100	57
Toledo, Ohio (0·3)	605	600	3	—	1008	75
Trenton, N.J. (0·13)	375	286	2	—	1311	183
Enclosed garages :						
Boston (0·8)	1200	800	3	1	1500	80
New York (7·9)	750	360	5+roof	2	2083	42
Trenton (0·13)	925	405	1	2	2284	238
Underground garage :						
Chicago (3·6)	8300	2359	0	2	3518	136
Mechanical garages :						
Chicago (3·6)	1657	715	13	1	2317	29
	970	420	8	—	2310	45
	1089	495	12	—	2200	30
Harrisburgh, Pa (0·09)	350	240	5	—	1458	70
Washington, D.C. (0·8)	—	72	16	2	—	23
Parking lots :						
Chicago (26 sites)	4285	2549	1	—	1680	—

* The figures in brackets denote the approximate population in millions.

Fig. 16—Simple steel structure open-deck garage in St. Louis, Mo.

Fig. 17—Mechanical garage in Harrisburgh, Pa

St. Louis, where there is a large municipal off-street parking lot on the waterfront (Fig. 21), situated about half a mile from the business district, the parking fee is 25 cents all day or 4 dollars per month. In the business district the parking lots and garages usually charge about 50 cents for the first hour and 20 cents for each additional hour, with a maximum of about 1·50 dollars per day. In Pittsburgh, where there is also a large waterfront park, the charge is 40 cents all day; this park is, however, nearer to the business district than that in St. Louis.

Influence of the Parking Problem on Property Values

As already mentioned, one of the consequences of inadequate parking facilities in cities has been a decline in the property values of city business areas. In New York, central business district valuations in 1945 showed a decline of over 20 per cent since 1930. Philadelphia showed a reduction between 1936 and 1946 of 29 per cent, Detroit 15 per cent and Boston 25 per cent. These declines have led to a reduction in tax revenue, and, to maintain services, the level of taxation has had to be increased for the central business area; this still further increases the tendency to move to the suburbs. Many cities and municipalities are greatly concerned over the decentralisation and consequent slump in business area property values, and associations of business men are being set up with the object of persuading the local authorities to take more effective action, including the provision of more parking facilities.

Fig. 18—Car being delivered from mechanical garage in Harrisburgh, Pa.

Fringe Parking

Some cities have tried the experiment of allocating parking space in the undeveloped or fringe areas and providing public transport from them to the business district. In some cases, however, these have so far proved failures, even when no charge is made for parking, but in others—for example, in Cleveland, Ohio, the fringe parking areas are well used and much appreciated by drivers.

Enforcement of Street-Parking Regulations

Much attention is paid in the United States to the enforcement of street-parking regulations. There is little doubt that, without enforcement, the regulations would be largely ignored, and the "ticket" system is widely used for dealing with parking offences (as well as other traffic violations). This system enables a policeman to issue a summons against the registered owner of a vehicle without the need for the summons to be presented in person, or for the appearance in court of the policeman or of the offender (unless he elects to appear). This saves the time of the police, offenders and the courts; less than 1 per cent of offenders elect to appear in court. Fines, which vary greatly in different cities and which range from 1 to 20 dollars, are paid on the spot to the policeman, or to the Motor Vehicle Department of the city either in person or by post. In the larger cities, the police have powers to move a parked vehicle if it is left at certain places. The offender has to pay the cost of removal and a fine.

Without these methods of enforcement, American courts would be quite unable to deal with the enormous number of drivers who offend against the parking regulations. As a means of dealing with minor offences, these methods have much to recommend them.

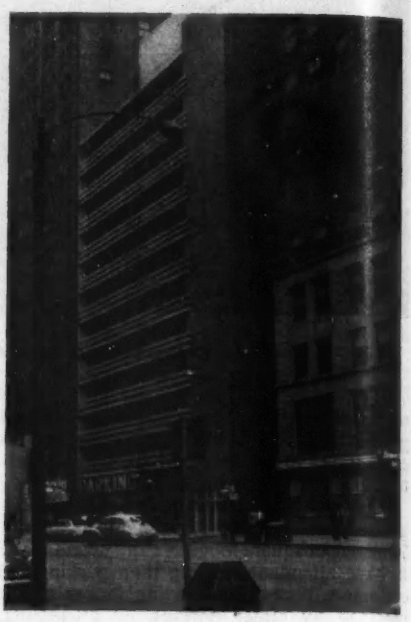


Fig. 19—Mechanical garage in Chicago

Acknowledgments

The material on which this article is based was collected while the author was serving with the United Kingdom Scientific Mission in Washington, D.C. The author wishes gratefully to acknowledge the facilities made available to him, and especially the help and encouragement given by Mr. H. J. Hadow, the Director of the Mission, and members of his staff. The article is published by permission of the Directors of Road Research, United Kingdom.

References

[7] Ricker, E. R.: "The Traffic Design of Parking Garages, Saugatuck, Connecticut, 1948" (Eno Foundation for Highway Traffic Control).

[8] Portland Cement Association, "Parking Garage Layouts," Pamphlet No. 24, Chicago 10, Illinois.

[9] Clements, S. O.: "The Largest Underground Garage," *Traffic Quarterly*, 1953, 7 (1), 124–33.

[10] Fisher, V. T., and J. J. Gould: "Another Underground Garage," *Traffic Quarterly*, 1953, 7 (7), 324–35.

[11] Pittsburgh Regional Planning Association, "Parking Study of the Pittsburgh Central Business District," 1946 (Pittsburgh Regional Planning Association).

[12] Burrage, R. H.: "Customer Self-Parking," *Traffic Engineering*, 1955, 25 (6), 217–24.

Fig. 20—Underground garage in Pittsburgh, Pa.

Fig. 21—Off-street parking lot in St. Louis, Mo.

Sharing the Blame

By a BARRISTER-AT-LAW

IT is only in very recent years that the law has adopted the policy of awarding compensation for injuries in proportion to the blame for the accident which caused them. Even now certain anomalies are apparent in the practice of the courts, some of these being legacies from the old system, others inevitable because of the difficulties of reducing to mathematical percentages the blame for an accident which occurs as a result of a number of different acts of carelessness or deliberate neglect. Another difficulty in reconciling decisions of the courts with everyday notions of natural (or, in some cases; almost poetic !) justice, is that the law usually takes no account of motives. A man may be guilty of a slight act of neglect while performing gratuitously some undoubtedly charitable act from the highest motives, and yet have to pay heavily for the consequences, whilst another may escape lightly because the damage was light when some deliberate disregard of the safety of others has caused an accident.

Nevertheless, the principles on which damages are awarded for an accident are better than they used to be. Up to 1945, for instance, any person claiming damages for personal injuries was deprived of his right altogether if he had been guilty himself of any substantial act of carelessness which had contributed to the accident, even though the carelessness of the other party might have amounted to almost criminal negligence towards the world at large, whilst the claimant's carelessness was no more than a passing disregard for his own personal safety. Since the passing of the Act of 1945, however, the principles on which claims for accidents are adjudicated by the courts have been changed. Where several factors appear to have contributed to an accident the courts do not approach the problem by endeavouring to ascertain which person had the last chance of avoiding the accident (the old principle), but they take all the factors which have contributed and apportion the blame accordingly, endeavouring to reduce to a matter of mathematical percentages of the total damage the contributions of all those who have neglected their duty of care.

Another change in the law the following year radically affected the responsibilities of employers for industrial accidents: formerly, an employee who was injured at work by the carelessness of a fellow-worker had no cause of action against the employer, because it was always the law that by accepting employment he was impliedly consenting to undertake the risks at work which arose from the careless acts of his fellow-employees. Now, however, this doctrine of common employment has been abolished, and the employer is responsible for all the negligence of his employees which cause injury to their fellow-workmen, in just the same way as he has always been responsible for acts which cause injuries to outsiders. This last change in the law has led to some slightly ridiculous results at times: if two employees who work together at a machine notice something wrong and together decide to do nothing about it, and an accident occurs to one of them as a result, the man injured will recover half the proper compensation for his injury if the courts later find that the accident was solely caused by the failure to report that something was amiss. This is because each was half to blame for the failure to report and, while the injured man is responsible for his own negligence, the employer is responsible for that of the fellow-workman. The courts assess the total damages payable to an injured man and then decide his own responsibility for the accident and deduct accordingly. This seems logical enough, and it still seems logical when both the men responsible for the accident are injured, though it is a little more difficult at first to see then why the employer should pay anything. Suppose, though, that there are sixteen men working on the machine and they are all injured; then the ridiculous position is reached that although the sixteen men together are responsible for the accident in which they are all injured, the employer pays in each case fifteen-sixteenths of the damages! That is the inevitable logical result of the application of the two principles.

There is a further anomaly in the present system, which was illustrated recently in the courts when an action arising from a factory accident was taken to the Court of Appeal. A man was assisting in the work of transferring a number of heavy cores from one wagon to another in a factory by signalling to the crane driver, whose view was obscured by the angle at which the crane was working. One of the cores which was being transferred swung sideways when it was lifted, and crushed the hand of this man. He sued his employers for negligence, and the causes of the accident were found at the trial to be two; in the first place, the man who was injured was himself at fault in not having ensured that the hook of the crane was centred before giving the signal to hoist. In the second place, the crane driver (a woman) was at fault in not pausing after taking up the slack, for if she had done so it would have been obvious that the hook was out of centre. Instead of deciding that each was half to blame for the accident, however, the Court of Appeal stated that the man's own negligence was so slight that it could not be said to have contributed materially to the accident at all in all, and they held the employers wholly responsible, through the crane driver.

In law the standard of care for a person's own safety is lower than the standard owed to other people. The explanation of this lies in the law before 1945. Then, an act of carelessness for his own safety barred the claim of a workman entirely, and the courts were thus not so keen to dub as legal negligence slight acts of carelessness by a workman for his own safety, for it is well known that many workmen accept small risks daily on their own account in order to do their work faster. In consequence of this it is still the law to-day that slight acts of carelessness by a workman which lead to an accident in which he himself is injured are not viewed so seriously as when they cause an accident to other people. That is not to say, of course, that the workman can act with impunity in disregard of his own safety in the confident knowledge that his employer will pay compensation every time. If a workman is deliberately careless of his own safety and the accident can be laid at his door alone, he will recover nothing.

A man was injured recently because he stepped forward too promptly to free a load of metal sleepers which had stuck when being lifted by crane. The pile of sleepers was very badly stacked, and the lifting was being done more or less haphazardly, by putting a sling around those which appeared convenient and then giving the signal to hoist. If the ends stuck, a man stepped forward with a crowbar to free the obstruction. The man in question stepped forward on one occasion to free the end, and just as he got to it the end swung clear and caught him in the leg. He sued the employer, and recovered some £30 in the County Court, the Judge holding that there should have been supervision to ensure that the man did not step forward before the hoist was slackened. The employers, he held, were two-thirds to blame. The Judge also went on to say that the man was partly to blame as well, because he knew of the danger that the end might swing clear. The Court of Appeal thereupon stated that if the man himself knew of the danger any supervision was superfluous, and the man must be held entirely responsible for his own misfortune.

This is not to say, however, that the employer will escape responsibility altogether because some foolish act of the workman was chiefly responsible for an accident. Particularly when there is some breach of the strict provisions of the Factories Act the courts go to some lengths to attribute some responsibility for an accident to such a breach, even in circumstances in which at first sight the breach seems to have had little direct bearing on the sequence of events which led to the accident. There have been two such cases recently before the courts in which workmen engaged on some activity which was not only plainly dangerous, but also against instructions, have recovered compensation in part against their employers because of some breach of the Factories Act. On these occasions it was not contended that the breach was the direct cause of the accident at all, but merely that had the employers complied with the obligations imposed upon them by the Act the workman might have been discouraged from his dangerous actions.

In the first of these two cases a workman operating a machine for cleaning metal castings climbed up to replace a pulley rope 9ft above ground, which had slipped off and stopped the machine. His instructions were to inform the foreman and wait until the maintenance fitters arrived to replace the rope, but on this occasion, "in flagrant defiance of the established practice," he made use of a nearby ladder to climb up and attempt the job himself. He slipped and was injured and sued his employers, who, after appealing to the Court of Appeal, had their share of responsibility reduced to 10 per cent. They were to blame, the Court held, for not having the transmission machinery fenced, as required by Section 13 of the Act, although the machinery was out of reach. If the pulley had been fenced the workman might have been deterred from climbing up to tackle the job himself.

In a rather similar case a week or two later a workman recovered some 20 per cent of his damages from his employers when he, once again in the face of obvious danger and against the established practice and instructions, climbed up to clean a piece of machinery in motion. The plant in question was sand-cleaning equipment, which had itself to be cleaned daily. On the day in question work had finished earlier than usual and the man, presumably in enthusiasm for his work, deliberately switched on a power-driven roller to clean it in motion, although it had always been cleaned while stationary. His injuries were assessed at some £2000, of which he recovered one-fifth from his

employers. The machinery, said the Court, was such that danger could reasonably be expected from its use, and it ought therefore to have been fenced in compliance with Section 14. If it had been fenced the man would not have attempted to clean it in motion, or, at any rate, might have been deterred, so the breach of the statute contributed to the accident.

The Court commented in this case on the difficulty, which must be apparent to all who consider the problem, of assessing the respective shares of the blame for such an accident as this when a "static" breach of the Factories Act on the part of the employer is combined, as it so often is, with an "active breach" on the part of the workman. Then perhaps the only guide to the degree of blame on each side is the extent to which each acted in the face of apparent danger. As far as this can be assessed, this is the extent to which the law says each shall contribute to the compensation of an injured man.

Further French Locomotive Experiences

By EDWARD H. LIVESAY

(*Concluded from page 367, September 14th*)

No. VI—HEAVY FREIGHT LOCOMOTIVES IN THE NORTH-EASTERN REGION; VALENCIENNES–CHARLEVILLE–CONFLANS–HARGARTEN (Part II)

THE next morning, fine but still cool, we drove through a nipping and an eager air to Audun-le-Roman, to pick up an unusually interesting engine, built for the P.L.M. Railway some twenty years ago, and designed by Monsieur Vallantin, with wheel arrangement 2–10–2, four-cylinder compound, and all four cylinders outside (Fig. 4). The driving wheels are in two groups, of two and three axles, respectively, coupled by rods working on cranks between the frames, thus keeping the two groups "in phase"; the l.p. cylinders drive the leading two-axle group and the h.p. the second three-axle group. The arrangement, so far as the outside mechanism is concerned, is shown in Fig. 4. This utilisation of inside coupling rods is not original, Stephenson patenting the idea as far back as 1815, and unless I an mistaken, he actually built an engine embodying it. The principal aims of the designer were to produce a powerful four cylinder, ten-coupled compound engine, with all the cylinders and valve gear outside without excessive axle load, with moderate total weight and these objectives were achieved. In the light of subsequent knowledge, simpler and less costly arrangements have proved preferable, but the fact that the engines have given thirty-five years' good service speaks well for the practical nature of the original plan. The chief dimensions are given in the table, but it should be mentioned that the engines were rebuilt and certain features modified in 1942/45.

With compound engines the cut-off is generally longer in the l.p. than in the h.p. cylinders, to ensure approximately equal power in the two pairs. This is brought about in the de Glehn system by independent adjustment of the h.p. and l.p. valve travel,

2–10–2 *Four-Cylinder Compound*

Cylinders, h.p.	18·9in by 25·59in
,, l.p.	29·33in by 27·56in
Ratio, h.p. to l.p. cylinders	1 to 2·29
All pistons fitted with enclosed tail-rods	
Valve-gear, "Dabeg" rotary-cam poppet type, both sets controlled by one wheel, fixed ratios.	
Driving-wheels, dia.	6ft 11in
Heating surface, tubes and flues, fireside	2374 sq. ft
,, ,, firebox, fireside	250 sq. ft
,, ,, superheater	986 sq. ft
,, ,, total	3610 sq. ft
Boiler, dia.	5ft 11¾in by 6ft 6½in
,, length between tubeplates	19ft 7⅛in
Steam pressure	285 lb
Flues, 141, dia.	2¼in
Tubes, 33	5·31in by 5·63in
Grate area, hand fired	54 sq. ft
Weight, on drivers	90 tons
,, engine	120 tons
,, tender	62 tons
,, total	182 tons
Coal	7 tons
Water	28 tons
Tractive effort, compound, at 75 per cent...	49,470 lb
Factor of adhesion	3·09
H.P., metric	2820
Fittings, Dabeg feed-water heater, 1 injector.	
,, Double blastpipe and chimney (P.L.M.).	
Westinghouse brake, compound pump. electric light. Flaman recorder.	

but with cam-operated gears as fitted to the engine under consideration, cam contour does the same thing in a simpler way, without manual manipulation. Live steam is admitted to the l.p. cylinders at starting by a hand-operated valve, excessive piston load being obviated by a reducing valve.

With Monsieur Forray, chief mécanicien Jaillard, mécanicien Captaine and chauffeur Quentin in the cab, making five with the writer, we left the shed running light, but coupled to another engine, for the village of Mercy-le-Bas, where there was a "model" iron ore mine, opened since the war, all the buildings and equipment being very up to date. After backing a few empties into the loading space, the complete train not being ready, orders were given to pick up a full 1750-ton train at Pierrepont; we left at 9.25 a.m., immediately attacking a very heavy gradient up which the train was taken at 12 m.p.h. with a pusher behind, We were at this period retracing our steps to Audun-le-Roman, where there was a 20 min stop to let another train get well ahead (Fig. 6). Right-handed running was the case here, it being Alsace, where this is the rule. My sympathy was extended to the fireman, hand-firing what again looked as poor a coal as seen in France; it was almost pure dust, the result of merciless screening. Wherever the good coal goes, it seems that the S.N.C.F. only gets the residue, the worst falling to the lot of the unfortunate freight engines.

The environment this day was predominantly industrial, the country round Florange and Thionville being typical of any district producing coal and iron in the raw rather than finished goods. Many large works had evidently been expanded since the war, yet, though the landscape was dotted in every direction with smoking chimneys, the general aspect was far less drab and sordid than older mining and manufacturing areas in Britain; it was cleaner, better planned, more orderly and far more liveable.

After Thionville gradients became long and heavy, as the profile shows, 1 in 100 being common, on which the pusher's services were invaluable; it certainly did its full share. The country became increasingly hilly and tunnels more frequent. Nearing one, which was said to be hot, I was urged to use, and was offered, a respirator; but loathing, as I do, any restriction against free air, I delined it, preferring sulphur to suffocation. The tunnel did prove to be hot, but quite bearable, and not very long; the famous Field Spirals in the Canadian Rockies are far more trying—or were in the days of steam power. No respirators were ever provided for them; a wad of waste over one's mouth and nose was considered sufficient filter. Nearing our destination two more tunnels were negotiated; there was plenty of curvature, while the ruling gradient was still 1 in 100. On emerging from the second tunnel at Teterchen, I noticed we had lost the pusher, which had dropped off *in medias res*, and I found myself looking down on to the little railway town of Hargarten-Falck, lying snugly as in an amphitheatre, within a ring of wooded hills, the train coming to a stand in the yard at 1.40 p.m. We were all ready for lunch at the Hostel, which was soon prepared, though it was after the regular luncheon hour, and a very nice one it was, too, of several courses, plus wine. I thought of the sort of lunch one would probably get at a similar caravanserai in England—10 to 1

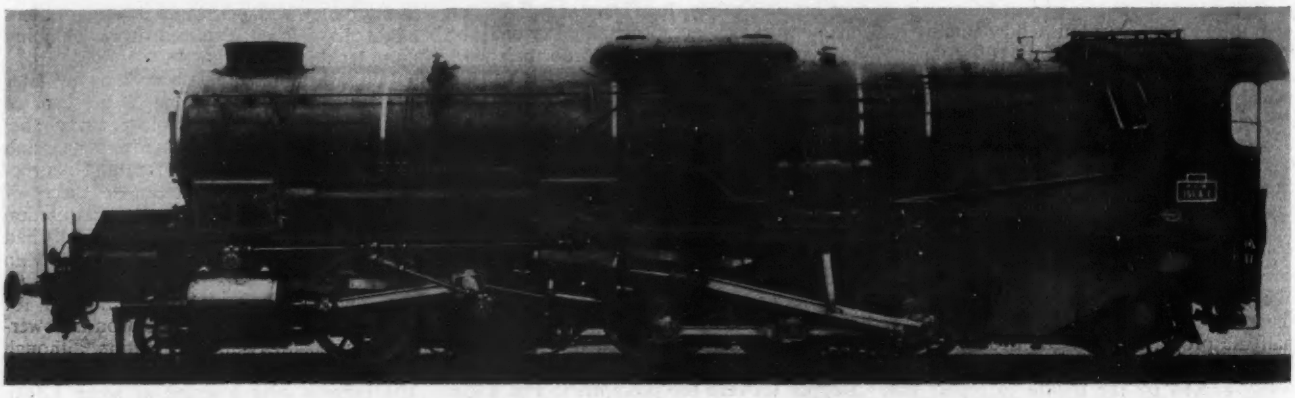


Fig. 4—2-10-2, four-cylinder compound freight locomotive

fish-and-chips, minus even beer ; " Sorry, Sir, we're not licensed ; no, the pubs. aren't open yet." Disastrous ! I love my native land with a deep and abiding affection, and try not to kick at anything, but I prefer lunching in France, where gastronomy is an art, not a catastrophe.

In my notes I cannot find anything of a critical nature about this very unusual engine, so it is safe to assume there wasn't anything much to find fault with. To get a tractive effort of nearly 50,000 lb from an engine weighing 120 tons is intriguing, especially where the factor of adhesion is only 3·09. Possibly the full tractive effort is only an ideal, which it is not seriously intended to reach. We have the same sort of thing in a famous and very successful English locomotive—the ex-Southern " Schools," which have three—is it 16in ? —cylinders and but 44 tons adhesion weight, or it may be a trifle less : I haven't the exact figures by me. Yet they do very fine work, as is well known, which I have admired on several occasions.

As was stated, the respective cut-offs of the h.p. and l.p. cylinders are at a fixed ratio, according to the setting of the cams ; they are as follows :—

Cut-off per cent, h.p.	30	35	40	45	50	65	95
" " " l.p.	40	44	50	56	63	75	95

A special cam keeps the valves off their seats when drifting. The brake was Westinghouse with compound pump, and counter-pressure apparatus was also fitted, which I wasn't aware of at the time, and therefore have nothing to say as to its working ; there were certainly plenty of steep gradients on which to use it. In spite of the lengthy wheelbase, curvature was taken without any objection, all the driving axles being allowed some side play, and the flanges of the second (h.p.) group of wheels reduced in thickness. Altogether an interesting and unique machine, the performance of which I was glad to have an opportunity of observing before the rising tide of electrification engulfs it—which it probably has by now.

From Hargarten we went by car to Metz ; a very pleasant drive through pretty country, followed by a brief stroll about the city and a visit to the beautiful cathedral. I left Metz on a fine 4-8-2 No. 241/A18 for Bar-le-Duc, with mécanicien Laine and chauffeur Denojelle; an Eastern Region machine this, similar to the one ridden from Nancy to Paris during my previous pilgrimage, as described in THE ENGINEER of June 4, 1954. The load was light, 400 tons, and the weather had deteriorated, becoming rainy and blustery ; moreover, I was tired, so took no notes, beyond the fact that the speed was limited to 110km, and the colour-light signals showed up brilliantly through darkness black as a pocket ; the run occupied an hour and a half, from 6.18 to 7.47. Doubtless we arrived on time; I cannot conceive a French train not doing so. As it was a wretched night, now raining harder than ever, being by this time still more tired, I regretfully sidestepped the engine, a fine 4–8–2 of the same type as that upon which I had come from Metz, and sank with a sigh of relief into the soft upholstery of a first-class compartment ; for once comfort had come before duty. The train pulled out of Bar-le-Duc at 7.59, and shortly after I became dead to the world; waking up about 9 p.m., I was treated to an amusing illustration of the wide difference between Gallic and Britannic railway procedure. The ticket collector arrived upon his round, to find something amiss with the " transportation "—the latest Canadian and probably American inanity—of a fellow traveller. They began talking—I fell asleep—on waking an hour or so later they were still at it—again I slumbered, and awoke—the same, and repeat, three or four times. The contestants were not heated, nor very argumentative—they just went on talking, talking. To cut a long story short, we were nearing Paris when I woke for the last time, to see the ticket collector retire defeated, the passenger sinking back in his seat with a satisfied sigh. *What* they could possibly have been disputing for over two hours I cannot conceive, but can anyone imagine a similar incident taking place in England ? A discussion between a train hand and a passenger in the southbound " Queen of Scots," beginning, let us say, at Grantham and continuing without pause or assault until the train sailed through Potters Bar to enter upon the final 14-mile drop into King's Cross ? No, it is unbelievable ; one or other of the disputants, or both, would have run out of words after five minutes, or some conclusion would have been reached. But this was France ; besides, French is, we are told, the language of diplomacy ; evidently that passenger was a diplomat.

So ended these three tough but very interesting days on freight engines, made all the tougher by my own poor condition and inclement weather, cold and dull, quite unlike my conception of France in September, so I may be forgiven for succumbing to the seduction of a comfortable compartment in the train rather than braving the austerity of a cab on a bad night. Anyway, I dislike cab travel after dark, even on an electrically lighted engine. We had left Bar-le-Duc at 7.59 and arrived in the Gare de l'Est at 11.10 p.m., having made several stops in the 157½ miles, and an average inclusive speed of nearly 50 m.p.h. Monsieur Forray, kind soul, piloted me right to the haven where I would be, the Gare St. Lazare, via the Metro, where we said " *Au revoir*," and I thanked him sincerely for the admirable way he had looked after me throughout the lengthy, complicated excursion. That is how the S.N.C.F. treats a peripatetic English observer ; I doubt if we should ever reciprocate to anything approaching the same degree. My gratitude is also extended to Messieurs Parmantier, Segaud and Chapelon, without whose help and co-operation the tour could not have been undertaken, and the many officials of lesser degree who without exception showed kindness and good fellowship. And certainly not forgetting the mécaniciens and chauffeurs, whose grubby hands were always extended in friendship—and never rejected.

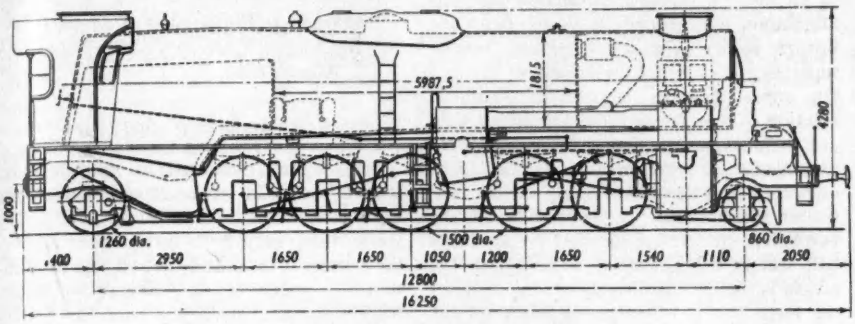


Fig. 5—Details of 2-10-2 freight locomotive

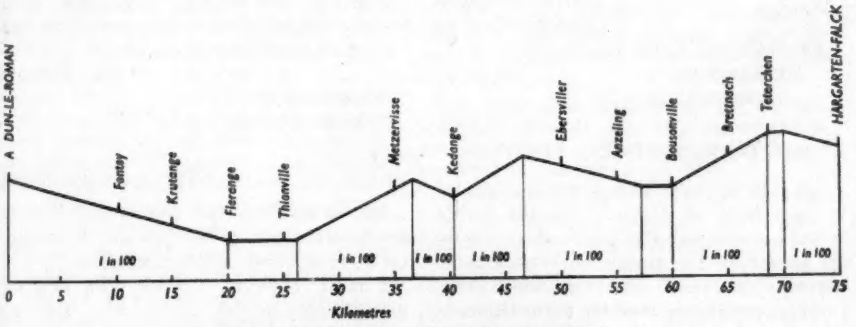


Fig. 6 —Profile, Audun-le-Roman/Hargarten-Falck

Shipping Federation Scholarships

THE Shipping Federation has stated that more men with Extra Master and Extra First-Class Engineer certificates are required as lecturers at colleges which prepare candidates for navigating officers' and engineer officers' certificates. With the aim of encouraging suitably qualified officers to take the courses leading to the Extra Master and Extra First-Class Engineer certificates, the Federation has decided to finance each year four scholarships tenable at such courses. Each scholarship will be valued at £250, without regard to the means of the holder. This sum is intended to cover a course of three terms' duration. Two will normally be awarded annually for Extra Master and two for Extra First-Class Engineer courses. The Merchant Navy Training Board has agreed to administer the scheme and a committee will interview candidates who appear suitable for an award after written applications have been considered. Subject to the agreement of the Board, the scholarships will be tenable at any college in the United Kingdom which runs appropriate courses. Further information as to conditions and application forms can be obtained from the Secretary, Merchant Navy Training Board, City Chambers, 65A, Fenchurch Street, London, E.C.3. The first scholarships under this scheme become available in 1957. The closing date for entry for the first scholarships is October 31st next. Subsequently the closing date will be June 30th in each year.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

OLD STUDENTS OF UNIVERSITY COLLEGE LONDON

SIR,—I should be grateful if you would grant me a little space in your columns to try and make contact with old students of University College London, of whom we calculate there must be some 30,000 either in this country or overseas. Unfortunately, we have got records of the careers and up-to-date addresses of only a very small proportion of this number. The College authorities are anxious to get in touch with old students, to invite them when possible to appropriate College functions, and on occasion to seek their advice. It is only when some honour, public appearance or other matter is recorded in the Press that the College can add to its records of the individual concerned.

The College authorities hope that old students will write, even just a postcard, to the Secretary of University College London, Gower Street, London, W.C.1, giving their addresses, dates at College, and subjects studied, and will keep the secretary informed of changes of address.

IFOR EVANS,
Provost

University College London,
September 10th.

ALL-WEATHER CONNECTORS FOR ALUMINIUM-TO-COPPER CONDUCTORS

SIR,—The article from your American Editor on this subject in your issue of September 7th is a most comprehensive survey and describes an interesting connector and the development work involved.

It is my impression that bi-metal connectors in general have given relatively more trouble in America than in this country, though the difference in demand is so great that one cannot be sure; however that may be, I think there is little doubt that such troubles as have occurred have in the main been examples of the old adage "penny wise, pound foolish." When considering connectors as such the user is naturally tempted to take into account first cost, but I can hardly think of a better example than this of a fitting where reliability is so important that cost should be disregarded until the reliability of each type in long-term service is established beyond doubt. The obvious reasons are (1) the inherent risk of trouble with bi-metallic junctions exposed to the weather, and (2) the almost negligible cost of the connectors in relation to the saving achieved by the use of aluminium conductors—and in relation to the cost of locating and changing the vast number of connectors which may have been installed over a period of years if they should prove to be unsatisfactory. It is clear from their thorough investigation of the problems that the Kaiser Aluminium and Chemical Corporation have appreciated the importance of these considerations.

I first encountered this problem nearly thirty years ago, and learnt this lesson. From that time there have been available in this country connectors based on the principle of an internal screwed connection between aluminium and tinned brass or phosphor bronze bodies with an insulating washer separating their outer faces, and so far as I am aware they are a complete technical solution of the problem, but, of course, they are more expensive than designs which do not involve accurate machining. Each half comprises an external cone grip on the conductor which is fully compacted before the two halves are screwed together. The rubber ball seal of the connector described in the article is clearly satisfactory on the basis of the tests, but it obviously depends on the ability of the rubber to resist the weather and maintain its grip, and both this feature and the weld depend entirely on quality of manufacture and accuracy of control in bulk production, whereas the insulating washer of a screwed connector depends for its effectiveness only on the machining of the clamping faces, as it is held securely in position and presents the minimum exposed surface to the elements. The acid test is long-term reliability in service, and the devising of "accelerated life tests" is, of course, an inherent problem in the development of new products.

J. R. HARDING,
General Manager
Pirelli-General Cable Works, Ltd.,
Southampton,
September 10th.

RESONANCE STRESS TESTING

SIR,—In the paper by B. Bramall, published in your issue of August 17th, the author includes a term $mk^2\,d^4y/dx^2dt^2$ in his equation (1) governing the transverse vibrations of bars with axial load. This term, which arises from the rotary inertia of the beam elements, is usually omitted in the elementary theory of transverse vibrations, since its effect on the fundamental natural frequency is very small for bars of normal L/k ratio. However, if for the sake of increased accuracy the author wishes to take into account rotary inertia, he should also include the effect of shear deflection, which results in a correction to the natural frequency several times larger than that due to rotary inertia alone. It may be shown (see Timoshenko, *Vibration Problems in Engineering*) that the inclusion of both the above effects results in the addition to the elementary bending equation of the terms

$$mk^2\left(1+\frac{E}{k^1G}\right)\frac{d^4y}{dx^2dt^2} \text{ and } \frac{m^2k^2}{k^1aG}\cdot\frac{d^4y}{dt^4},$$

where G is the modulus of rigidity and k^1 is a numerical constant depending on the shape of the cross section of the beam. (For a rectangular section $k^1=3/2$.) The second of these terms is usually of the second order of small quantities and may be disregarded. The effects of both rotary inertia and shear deflection can therefore be included in the author's analysis, without serious modification, by multiplying the existing term $mk^2\,d^4y/dx^2dt^2$ in his equation (1) by the numerical factor $(1+E/k^1G)$.

R. P. N. JONES
Postgraduate Department of Applied Mechanics, University of Sheffield,
August 21st.

VOLTA RIVER PROJECT

SIR,—I was interested to read in your issue of July 27th of the report of the Volta River Preparatory Commission. The report stated that, subject to certain reservations, the scheme is technically sound, but no mention was made of its political soundness. May I venture to suggest that the United Kingdom can ill afford to invest £230 million in a scheme which would be no safer than the Abadan refineries or the Suez Canal.

Perhaps it is not generally known that bauxite and adequate hydro-electric power are available in the Central African Federation, where government will remain in hands loyal to the British Crown. Although preliminary tests have shown that the bauxite in the Federation is less pure than that near the Volta River, further tests may well disprove this. In any case production problems are not insuperable. It would therefore appear wiser to produce aluminium costing a little more per ton, than to run the risk of losing control of the complete investment and having no aluminium at all.

C. L. WIGGINS

Nyasaland,
September 11th.

FRENCH LOCOMOTIVE EXPERIENCES

SIR,—I have read with considerable interest the contributions of Mr. Edward H. Livesay on his French locomotive experiences.

I must, however, disagree with him on his statement in your current issue when he says in his "experience very seldom is any real effort made to recover" time on British Railways, presumably by the driver, and further on he quotes a case where he arrived at his destination 42 min late. He says he cannot recall that the enginemen were very concerned. I can assure him, from a very wide experience of locomotive work, that enginemen are concerned when trains are not running to time, and they do make considerable efforts to recover time which is lost. It is a fact that they do not show their concern in the same dramatic manner that French nationals would do, but then, of course, they are not French nationals; that, however, does not detract from their anxiety to arrive at destination right time.

S. T. CLAYTON,
Motive Power Superintendent
London Midland Region,
Euston House,
Euston Station,
London, N.W.1,
September 7th.

Literature

Theory and Practice of Lubrication for Engineers. By DUDLEY D. FULLER. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 84s.

FOR a bearing of conventional type to operate efficiently, the relationship between speed, load and lubricant viscosity must be such that sufficient fluid pressure to separate them is generated by the relative motion of the surfaces. When the bearing is required to carry full load as the mechanism is starting from rest or when loads are heavy and speeds very low, no hydrodynamic effect is present and lubrication depends on the chemical properties of the lubricant. This so-called "boundary" lubrication gives rise to a comparatively high coefficient of friction (about 0·1), to local heating and to wear. An alternative to boundary lubrication is "hydro-static" lubrication, wherein a pump is employed to force sufficient lubricant between the mating surfaces to separate them even in the absence of relative sliding.

A particularly striking example of hydrostatic lubrication is described by Professor Fuller in *Theory and Practice of Lubrication for Engineers.* This is the Hale telescope on Mount Palomar, which weighs about 440 tons but which can be turned to follow the path of the night stars by the exertion of only about 50ft-lb of torque. This is equivalent to a coefficient of friction of 0·000004. The operation is performed by a clock motor of one-twelfth horsepower. The telescope is supported on three pairs of oil pads, each being 28in square and having a white metalled surface curved to match the moving member. Oil is pumped to each pad with sufficient pressure to separate the surfaces and in sufficient quantity to provide a film 0·005in thick. Were this oil supplied to the centre of each pad there would be a risk of instability. If a pad tilted, excessive oil would escape from one edge, leaving the opposite edge in contact. Therefore, four recesses, each 7in square, are provided in each pad and supplied separately through restricting orifices. This confers stability, pressure being highest where the film is thinnest.

Starting from the development of the simple formula connecting pressure, viscosity and volume of flow through a shallow slot of infinite width, simple calculations are made of the various types of hydrostatic or externally pressurised bearing. Naturally, the most important quantity required by the designer is the viscosity of the lubricant. The methods used for determining the quantity are dealt with in considerable detail. In particular, in addition to defining viscosity index as is done in most texts, tabular matter is included to enable this quantity to be actually calculated for any sample.

The simple step bearing is described and appropriate formulæ for its design are developed. Moreover, it is shown that, for a given bearing, an optimum film thickness (equivalent to optimum pump delivery) exists so as to make the total horsepower consumed, friction horsepower plus pumping horsepower, a minimum. This is treated numerically and, indeed, the whole book is generously provided with numerical examples. The treatments are not, however, taken far enough algebraically to enable optimum designs to be obtained. It is presumably assumed that because a designer can, from the information given in the book and assuming initial dimensions, proceed to calculate bearing capacity he will, by a process of trial and error, soon arrive at a satisfactory design. There is no criterion provided, however, to determine whether or not such a design approached the optimum.

A further important application of the hydrostatic principle is to the starting of heavily loaded bearings whose lubrication at speed is satisfactorily accomplished by a self-generated oil film. Simple formulæ are given and tabular matter provided to enable the required pressure to be estimated in the case of a simple journal bearing. The treatment is approximate, but it is claimed that it has provided a sufficiently accurate basis for numerous successful designs.

The designer of heavily loaded, slow-speed machinery, such as swing bridges, machine tool slides, ball mills and crushing plant, will find Professor Fuller's treatment both adequate and stimulating. In particular, by reason of the ready supply of pressurised fluid, hydraulic machinery should provide profitable applications of the hydrostatic bearing principle. The most common application of the principle at present is, however, to the provision of truly frictionless pivots for instruments. The user of high-speed air bearings may encounter problems of instability which are not adequately dealt with by Professor Fuller.

Those portions of the book which deal with hydrodynamic lubrication are not so uniquely valuable. The treatment of the hydrodynamic journal bearing is based on Dennison's 1939 presentation and the full implication of more recent research on both sides of the Atlantic is not explored. No attempt is made to develop treatments leading to an optimum design, although, by following the examples given, estimates of performance can be made of bearings of which full dimensions were given or assumed at the outset.

The book has little to offer the designer of advanced high-speed machinery, such problems as bearing whirl being dealt with but superficially.

The three final chapters, on dry friction, boundary friction and bearing materials, provide a well-written and well-balanced survey of knowledge in this field.

The publishers, on the dust jacket, state: "All the engineer needs to know about lubrication—from the theoretical framework to practical applications." We cannot support this claim in so far as we feel that the designer of high-speed machines, engines, and so forth, will require to know more about hydrodynamic theory and to be more familiar with recent research than would result from a study of the present work. We do, however, recommend the book to those engineers who are concerned with the support of heavy loads at low speed or at the instant of starting. The simple treatment given should enable any draughtsman to produce workable designs of hydrostatic bearing, the application of which in many instances, we believe, would result in remarkable savings. Apart from the exaggerated claim on the dust cover, the author has been well served by his publishers, the book being very well laid out and illustrated.

Review of High-Temperature Technology. By I. E. CAMPBELL. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 120s.

THIS is a most useful book for those concerned with very high temperatures. It consists of the contributions of thirty-five authors to four main sections, one, introductory, two, on materials, three, on methods, and four, on measurements. It should first be made clear that the concept of high temperature in this book, as mentioned in the preface, applies primarily to service at temperatures above 1500 deg. Cent. This rules out materials commonly known to engineers as high-temperature alloys or super alloys and the field covered would be better represented by the term "extremely high temperatures."

The major criticism is that, being the work of so many authors, the contributions have not been sufficiently co-ordinated. They therefore produce a disjointed effect in reading the book and even in some cases give rise to apparent contradictions. As an example, in the introduction, we read that the major problem with chromium base alloys is the lack of ductility, whereas in the section on metals, chromium is rejected as entirely unsuitable because of its high vapour pressure at elevated temperatures. In a similar way, additions of tungsten to cobalt-nickel base alloys are considered in the introduction to be a promising field for development, whereas in the section on alloys these alloys are not mentioned, although a reader would have the right to expect a fuller treatment. The difference in emphasis laid on the high-temperature aspect by the various authors therefore tends to create some confusion in the mind of a non-expert reading about the work in this highly specialised field.

Materials are treated very fully, but metals as we know them are a basis of high melting point, low vapour pressure and adequate mechanical strength at temperature. This leaves only four to be seriously considered, namely, tungsten, molybdenum, tantalum and niobium. These are considered to be of general utility, but even these must be protected from oxidation by a suitable coating, and with the exception of tungsten have very poor mechanical properties at these temperatures.

The book considers that the greatest promise for the future lies in the development of binary elements of the platinum group. It is clear, however, that the use of metals at this temperature will never become extensive, and that in spite of their inferior resistance to thermal shock the future lies with refractories and cermets. Such materials are very fully dealt with, including high-temperature oxides, carbon and graphite, borides, silicides, nitrides and sulphides.

The sections of the book dealing with the means of achieving high temperatures, and the limitations and the measurement of mechanical and physical properties at high temperatures, are specially important. There is also a most important section on high-temperature techniques. On the whole, the book can be strongly recommended for guidance in the very high-temperature field. A good point about the book is that each particular article is accompanied by a very full list of references from which further information can be sought.

Books Received

Chambres D'Equilibre. By André Gardel. F. Rouge et Cie., S.A., Librarie de L'Université, 6, Rue Haldimard, Lausanne. Price 24·85 francs.

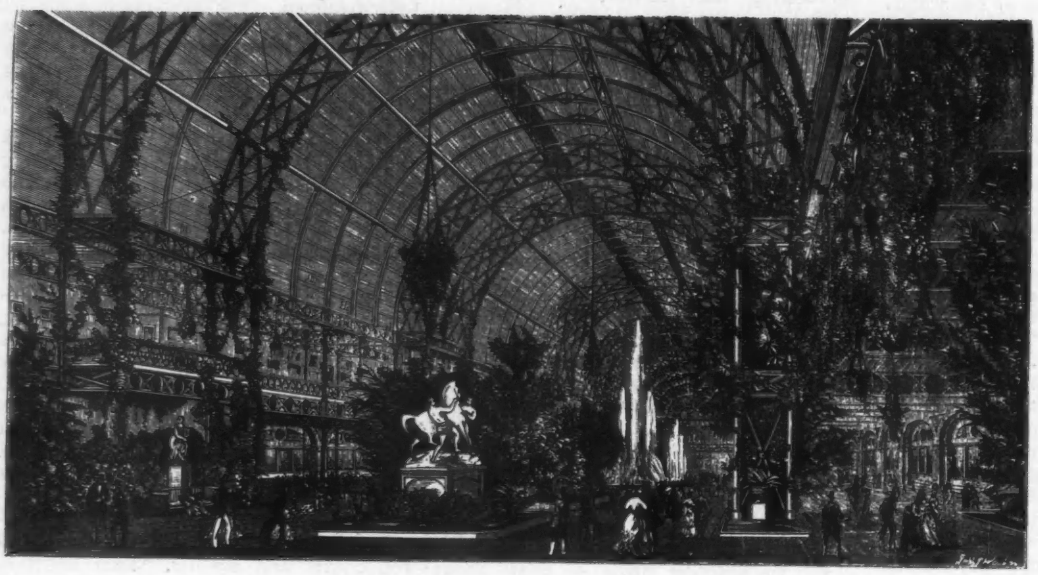
Aircraft Gyroscopic Flight Instruments. Sixth edition. Sperry Gyroscope Company, Ltd., Great West Road, Brentford, Middlesex. Price 6s.

The Theory of Machines. Third edition. By Thomas Bevan. Longmans Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 26s.

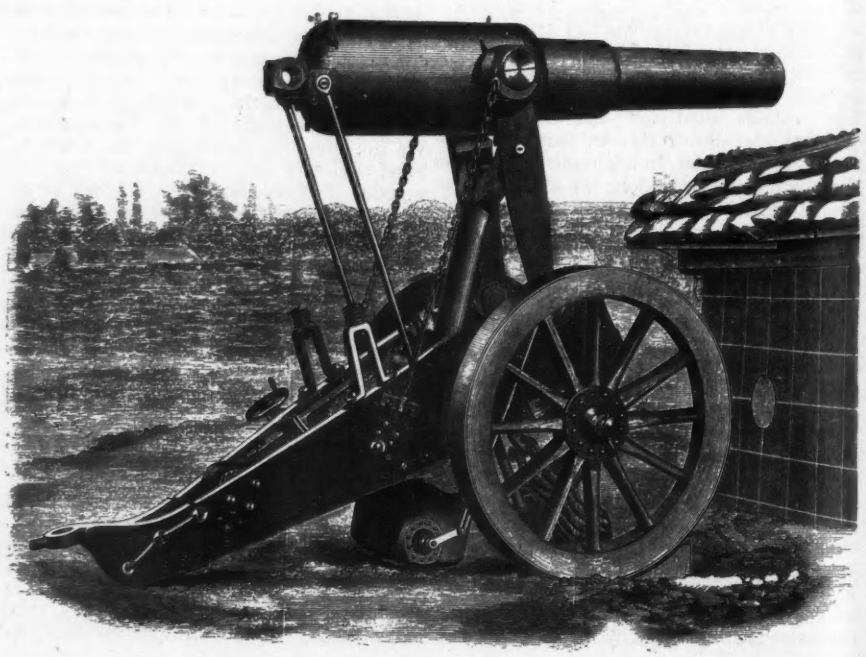
Colliery Year Book and Coal Trades Directory 1956. Published by Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 30s.

ENGRAVINGS OF 1875

The right hand engraving, reproduced from our issue of September 24, 1875, illustrates the "curious old railway bridge" at West Auckland, Co. Durham. This bridge, we stated, was most probably designed by Robert Stephenson, and "was certainly built by Messrs. Stephenson, of Newcastle, in 1825." Our note about it continues: "the bridge is almost entirely, if not wholly, of cast iron. It is situated on a level portion of the Stockton and Darlington line between Etherley down incline and Brusselton up incline. It crosses the river Gaunless, a tributary of the Wear, on four spans of about 13ft each. The columns are stepped on wood balks laid on the bed of the stream." This old bridge, we suggested, was "one of the most interesting existing relics of early railway practice."



In our issue of October 8, 1875, we included an engraving illustrating the interior of the main hall of the "Royal Aquarium and Winter Garden" at Westminster. It is reproduced here. The architect was Mr. A. Bedborough. The building was situated in Broad Sanctuary, and had a frontage of about 600ft in Tothill Street. The main hall was 350ft long by 160ft wide, and was "approached by two noble entrances from Tothill-Street frontage, surmounted by pediments." Our description of the building explains that "the central portion of the roof is semicircular and of iron, and is being glazed on the principle of Rendle's patent, by which invention all woodwork is covered with glass, no putty being used, and bent glass is entirely dispensed with. The ironwork has been supplied by the Thames Ironworks Company."



The Moncrieff Hydro-Pneumatic Carriage for Sixty-five Pounder Guns, which is shown in this engraving, was first illustrated and described in our issue of December 3, 1875. Major Moncrieff, who was responsible for the design, had been at work on this particular system for five years or so, and his "carriage" ultimately received the approval of a War Office committee. Our description says: "the apparatus consists of five parts, namely, the cylinder and plunger; the radius bars which support the gun; the elevating arrangement; the extra sights; the anchoring or pivoting arrangement. The cylinder is hydro-pneumatic; the pneumatic chamber surrounds the hydraulic cylinder, in the upper part of which the air is confined by the heavier non-elastic fluid below it—glycerine and water. The manipulation of the carriage is entirely hydraulic. The hydraulic action is effected by means of the main and the throttle valves, which are both self-acting and by the by-pass valve, which is acted on at the left trunnion by the hand of the man who runs up the gun to the firing position."

Four Automotive Diesel Engines

Four automotive diesel engines have been added to the range of engines manufactured by Henry Meadows, Ltd., so as to provide a greater degree of flexibility in meeting users' requirements. All the engines are six-cylinder units, based on existing designs, two being horizontal versions of the vertical engines and designed to make for greater adaptability. To reduce driver fatigue on commercial vehicles three of the company's gearboxes now incorporate a synchromesh system.

TO satisfy the present demand for more compact engines giving increased power, Henry Meadows, Ltd., Fallings Park, Wolverhampton, has been engaged in the design and production of new units which will meet users' requirements. These new units, which we were able to inspect recently at the company's works, will improve the flexibility of the company's range of engines to satisfy power requirements, and, by reason of the development of additional horizontal engines, provide for greater adaptability. Two of the new engines consist of a horizontal and a vertical version of the same design, while the remaining two are also horizontal and vertical versions of a similar design, except that the latter is turbo-charged. All the engines are being exhibited at the Commercial Motor Show, which opens at Earls Court to-day.

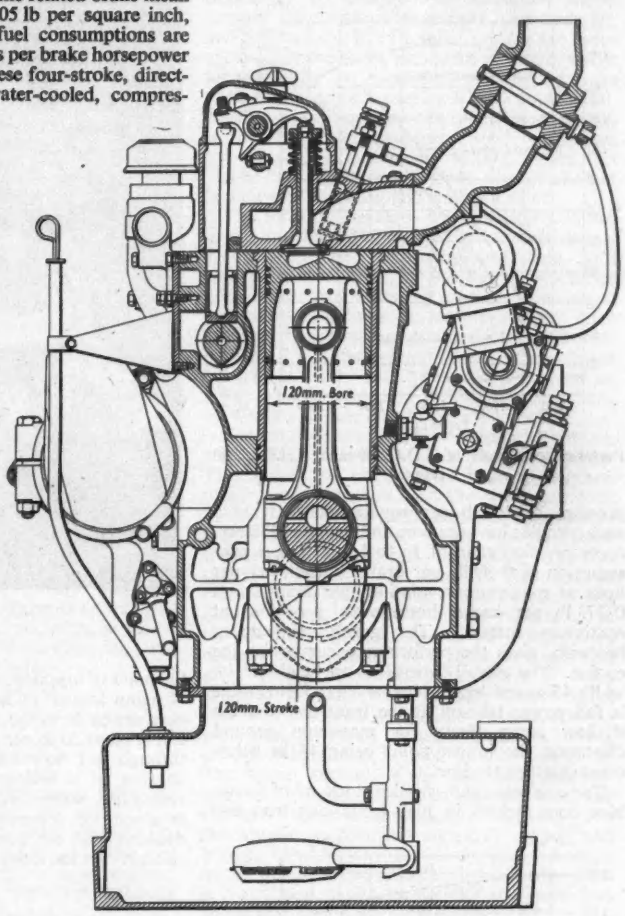
Based upon the proved design of the four-cylinder Mark 4 D.C.330 engine, the company has produced a six-cylinder engine having the same cylinder dimensions. This light weight, 8-litre unit, Mark 6 D.C.500, develops 135 b.h.p. at 2400 r.p.m., and is considered suitable for goods vehicles of 12/14 tons payload capacity, or coaches having forty-three seats. The horizontal version, Mark 6 H.D.C.500, is for under-floor mounting in passenger vehicles of forty to fifty-six seat capacity or goods vehicles of 12 to 14 tons payload. The second pair of engines are developments of the well-tried 6 D.C.630 engines, one being a horizontal unit, developing 130 b.h.p. at 1900 r.p.m., and suitable for under-floor mounting in passenger vehicles and goods vehicles of 15 tons payload and above. The other engine is fitted with a turbo-charger and develops 185 b.h.p. at 1900 r.p.m.

Mark 6 D.C.500 and 6 H.D.C.500 Engines

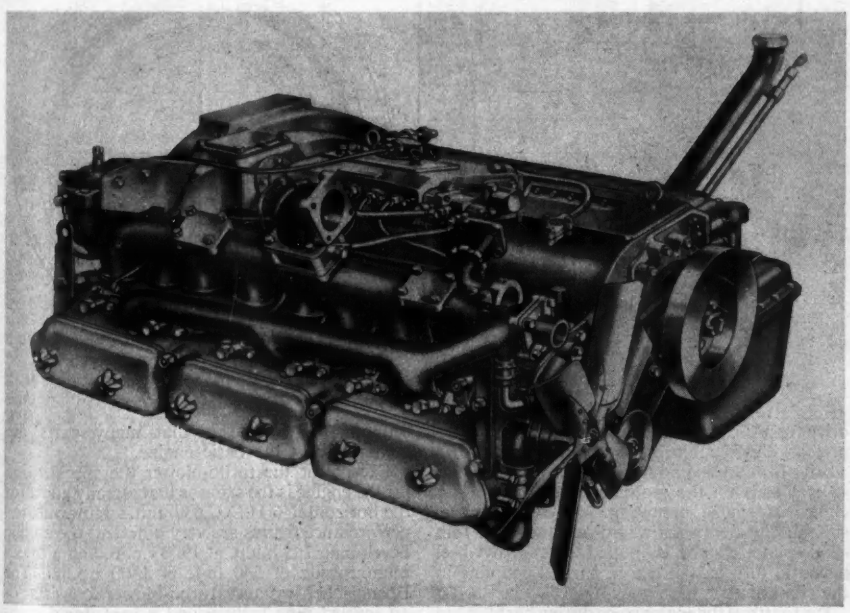
Both the horizontal and vertical "500" engines have the same main specification, each being six-cylinder in-line units having a bore and stroke of 120mm and a compression ratio of 16 to 1. The general construction of the engine can be seen in our cross section of the vertical model, while the photograph we reproduce shows the horizontal unit, and the graph indicates the performance curve of both engines. The maximum brake horsepower at 2400 r.p.m. at one-hour rating is 135, and the maximum torque is 346 lb-ft at 1400 r.p.m., the related brake mean effective pressure being 105 lb per square inch, while the corresponding fuel consumptions are 0·406 pints and 0·365 pints per brake horsepower per hour respectively. These four-stroke, direct-injection, cold-starting, water-cooled, compression-ignition engines combine small size with light weight and high power output. The principal particulars of the vertical engine are: Height, 40in; width, 25½in; length, 51½in, and weight 1740 lb (with compressor). The corresponding particulars for the horizontal engine are 26in, 41in, 51½in and 1685 lb.

A single high-grade iron casting forms the crankcase and cylinder block, and the same material is used for the detachable cylinder heads, of which there are three, each covering two cylinders and each having renewable valve seat inserts, centrifugally cast in high chromium iron alloy, to take one inlet and one exhaust valve per cylinder. Wet pattern cylinder liners, centrifugally cast in high-grade iron alloy, are fitted. Three compression rings, the top one being chromium faced, and two oil scraper rings, are fitted to the die cast aluminium alloy pistons, which have fully floating gudgeon pins. High-tensile steel stampings of H-section form the connecting-rods, which are drilled for lubricating small-end bearings consisting of steel bushes copper-lead lined. The big-end bearings are of thin shell steel backed precision pattern, copper-lead lined and lead-indium treated, and seven similar bearings carry the "Tocco" hardened crankshaft, which has provision for full power take-off at the front end.

There is a pressure lubricated camshaft having seven bearings, and the valves are operated by cast iron bucket tappets, short push rods and rocker arms. Both valves are of heat-resisting steel, the inlet valve being of normal symmetrical shape and not the usual shrouded pattern, an inlet port of special shape imparting the induction swirl. The exhaust valves are "Stellite" faced. Timing is by helical gears at the flywheel end of the crankshaft and incorporated is the Meadows automatic device to advance the point of fuel injection with increase of engine speed.



Cross section through 6 D.C.500 engine



Horizontal version of the Mark 6 D.C.500 diesel engine

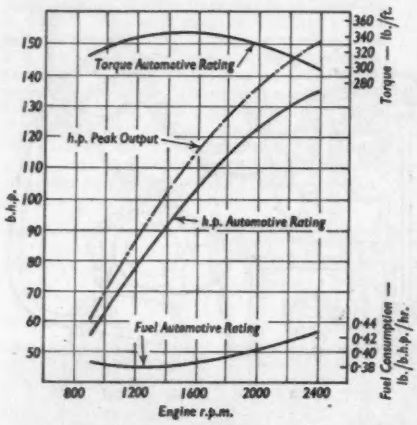
A lift pump mounted on the fuel injection pump delivers the fuel through a twin bowl filter to the inlet side of the injection pump, from which the fuel is solidly injected into the combustion chamber through long stem multi-hole nozzles. Lubricating oil, which is efficiently filtered, is delivered by a Hobourn Eaton gear-driven pump, at a pressure of 65 lb per square inch, to the main and camshaft bearings, rockers and gear drives. The wet sump of the vertical engine has an approximate capacity of 4 gallons, and is completely reversible, while the sump for the horizontal unit is of 3 gallons capacity. Cooling water is circulated by a belt-driven centrifugal pump mounted at the front of the engine and the temperature is controlled by a bellows pattern thermostat. An air-cooled exhaust manifold is fitted and provision is made for centre or end discharge at any angle. Starting arrangements are not included in the specification, but provision is made for fitting a 24V starter motor and dynamo.

Alternative specifications can be met, and include the supply of a mechanical or hydraulic fuel pump governor in place of the standard pneumatic fitting, a Clayton Dewandre

"500" "Tu-flo" compressor, of 9·35 cubic feet per minute capacity, or an "A500" exhauster. The scavenge pump fitted to the horizontal engine to return excess oil to the sump can be fitted to the vertical unit to provide a dry sump system.

Mark 6 H.D.C.630 and 6 D.C.S.630 Engines

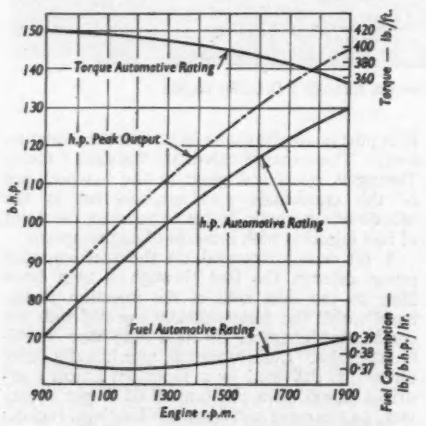
The Mark 6 H.D.C.630 engine is a similar four-stroke, direct-injection, cold-starting, water-cooled, compression-ignition unit of robust construction, which develops 130 b.h.p. at 1900 r.p.m., and a maximum torque of 420 lb-ft at 1000 r.p.m., with a brake mean effective



Performance curves of 6 D.C.500 and 6 H.D.C.500 engines

pressure of 105 lb per square inch. It is a square engine having a bore and stroke of 130mm, a compression ratio of 16 to 1, and a fuel consumption of 0·39 lb per brake horsepower per hour at maximum revolutions per minute and 0·373 lb per brake horsepower per hour at maximum torque. The graph, reproduced herewith, gives the performance curves for the engine. The overall dimensions are height 27¼in, width 45in, and length (engine only) 57¼in; there is full power take-off at the front end and the shallow sump allows for maximum ground clearance, the lowest point being 13½in below crankshaft centre line.

The crankcase and cylinder block are of monobloc construction in high-grade cast iron and

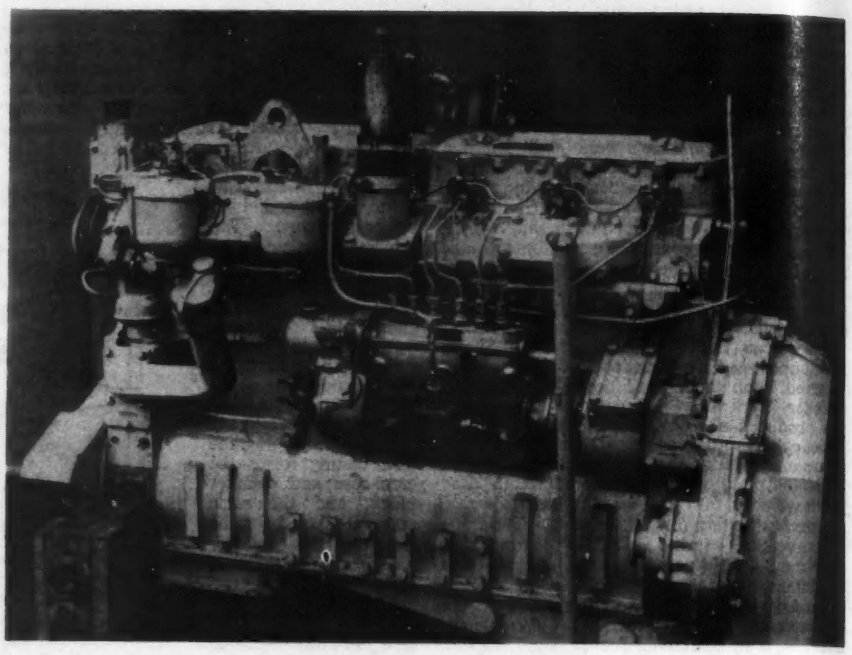


Performance curves of 6 H.D.C.630 engine

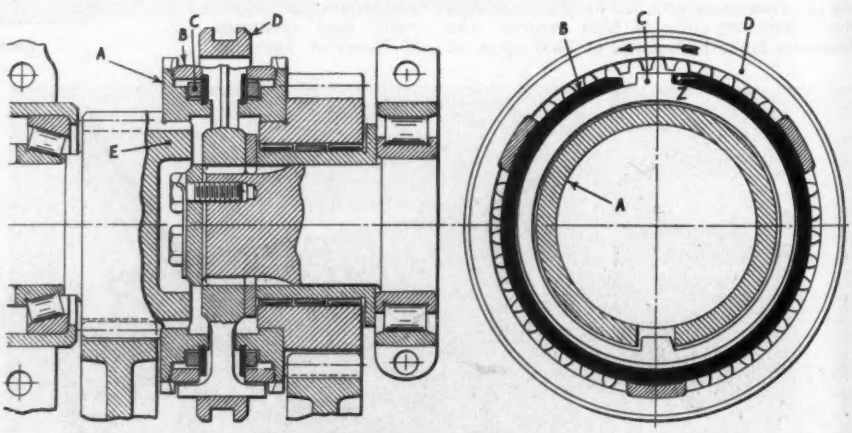
the two cylinder head units, also of high-grade cast iron, are detachable and interchangeable. The latter incorporate renewable inserted valve seats of centrifugally cast high-chromium iron alloy, and their design includes a method of controlling swirl. Centrifugally cast high-grade iron alloy replaceable dry liners are fitted. The aluminium alloy pistons have three compression and two scraper rings and a fully floating gudgeon pin, while connecting-rods are H-section steel stampings designed for easy removal through the cylinder bore. They are drilled for forced lubrication to the small-end bearing which is a pressed-in bush. A steel-backed precision copper-lead-lined and lead-indium-treated big-end bearing is fitted and seven similar bearings carry the hardened crankshaft. There is one inlet and one exhaust valve to each cylinder, operated through rocker arms, short push rods and cast iron tappets from a seven bearing camshaft machined from a steel stamping.

Fuel is solidly injected through long stem multi-hole nozzles and integral with the fuel injection pump is a mechanical governor and a Meadows automatic device which advances the point of injection as speed and load increases. A pump located at the front of the engine and gear driven from the crankshaft circulates lubricating oil at 50 lb per square inch, the oil passing through full flow filters. The cooling system consists of a bellows pattern thermostat and centrifugal water circulating pump. Provision is made for mounting a starting motor and dynamo and for connection to a suitable air cleaner. At the front end of the engine is a gear drive for a Clayton Dewandre 500 "Tu-flo" compressor of 9·35 cubic feet per minute capacity and a drive for a hydraulic steering pump. There are several pads on the gearcase so that there is a choice of engine mounting. A friction plate, suitable for incorporating a Borg and Beck 16in single-plate clutch, is bolted to the flywheel which in turn is bolted to a flanged coupling in the crankshaft.

The fourth of the engines seen during our visit and illustrated herewith, was the Mark 6 D.C.S.630 unit which is a 6 D.C.630 engine supercharged. This development has stemmed from demands for higher specific outputs and the turbo-charged 6 D.S.970 engine described in The Engineer of September 23, 1955, is stated to have achieved considerable success both as a marine and an industrial unit. The 630 engine has been developed for automotive purposes and in the initial stages positively driven Roots pattern superchargers were tested, but resulted in additional power being achieved, with a corresponding increase in fuel consumption. Eventually attention was directed to obtaining the required automotive torque characterisitics by turbo-charging and the engine has been fitted with a high-speed, low-inertia turbo-charger produced by the Eberspacher Company of Germany. The turbo-charged engine occupies the same space as the naturally aspirated unit, but offers a considerable amount of additional power for a moderate increase in cost. Another economic advantage is that many parts are common with the basic engine.



Supercharged 6 D.C.630 automotive engine



Details of 25 O.C.S.5 gearbox

Except for the turbo-blower the specification for the engine is the same as that already given for the horizontal 6 H.D.C.630 unit. However, the performance figures are very different, the engine developing 185 b.h.p. at 1900 r.p.m. and a maximum torque of 540 lb-ft at 1300 r.p.m. The Eberspacher exhaust turbo-blower consists of an inward flow turbine and a centrifugal compressor, employs ball bearings throughout, and

has a self-contained lubrication system. With regard to maintenance this is reduced to a minimum by means of a replacement scheme which provides for the fitting of a new blower, for a low charge, after 30,000 miles of operation.

Synchromesh Gearboxes

One of the new series of gearboxes which the company has developed was demonstrated during our visit. Constant load or baulk pattern synchromesh systems were considered to be not robust enough for commercial vehicle duty and the new range of gearboxes incorporate Porsche synchromesh mechanism. This only occupies the space normally required for a constant mesh design of sliding sleeve and dogs and the boxes can be fitted in the same space as that occupied by the orthodox constant mesh mechanism. An earlier gear developed by Dr. Porsche for sports cars was described in The Engineer of April 17, 1953.

The Meadows Mark 250 C.S.5 gearbox has a dry weight of 255 lb, a maximum input speed of 2400 r.p.m., and a maximum torque of 250 lb-ft. The casing, of high-grade cast iron, has internal ribbing to give strength and rigidity and the selector shafts, of bright drawn case-hardened E.N.32 steel, operate in an aluminium alloy housing. Taper screws secure the forged steel selector forks to the three shafts, which incorporate an interlocking mechanism which prevents the inadvertent selection of any gear while another is engaged. Case-hardened nickel chrome E.N.36 steel forms the main shaft and the first sliding gear is mounted on S.A.E. involute form splines. The first gear is integral with the layshaft, which is of E.N.34 nickel molybdenum steel case-hardened to V.P.N.720, while the other gears are mounted on S.A.E. involute splines. All the gears are machined from the same material as the layshaft, case-hardened to V.P.N.720 and lapped or shaved, and the teeth are of involute form, those of the reverse, first and second gears being straight spur, while those of the third, fourth and fifth gears are helical. The stem shaft, main shaft rear and layshaft front are supported in deep-groove ball races which absorb thrust in either direction, while the constant mesh main shaft gears run on caged roller races. The spigot bearing is a caged roller race of single lip pattern, as is also the layshaft rear bearing. Splash lubrication is employed and the normal capacity with the box vertical is ten pints, although this varies with the installation angle.

Power take-off through a straight spur gear splined to the layshaft is provided and designed to transmit up to 180 lb-ft torque. Porsche synchromesh is applied to the four high-speed gears, but the first and reverse gears can only be engaged by applying extra side force to the control lever. This is normally centrally mounted and acts directly on the selector mechanism. The gear ratios are as follows :

Gear	Overdrive	Underdrive
5th	0·76 to 1	1 to 1
4th	1 to 1	1·66 to 1
3rd	1·75 to 1	2·54 to 1
2nd	3·7 to 1	3·95 to 1
1st	6·12 to 1	6·53 to 1
Reverse	5·72 to 1	6·1 to 1

Our line drawing gives the details of the gearbox in which the driving members of the gear consist of the clutch body *A* shrunk on to the driving gears, the inner face of the clutch body being machined to form a small conical clutch face into which fits the synchronising ring *B*, consisting of a split spring ring faced on both edges with a mating cone. The synchronising ring is held in position radially by the supporting ring *C* which is driven round by an internal snug, and a projection on the outer diameter of the ring fits into the slot of the synchronising ring. A circlip locates the driving assembly in position. The driven members consist of a star-shaped hub *E* keyed to the driven shaft. When the sliding sleeve *D*, which is held centrally in position by the hub, is fully engaged, the drive is transmitted through the gear teeth of the clutch body *A*, meshing with the internal teeth on the sliding sleeve and thus driving through the hub *E* to the driven shaft.

Operation of the gearbox consists of moving the sliding sleeve towards the engaged position, when contact is made on the inner diameter of the internal teeth with the male part of the cone of the synchronising ring. This engages with the inner clutch face of the clutch body and thus a friction drive is imparted from the driving to the driven member. Since relative movement exists at this point, the pressure imparted to the sliding sleeve tends to move the synchronising ring in relation to the supporting ring *C*. Thus, the abutment on the latter unit is forced against one side of the slot in the synchronising ring and thus tends to open the ring and force the conical faces of the clutches harder into engagement. Thus, the relative movement between parts *D* and *A* is reduced until complete synchronising occurs. At this point no force is imparted by the abutment to the edge of the split ring at *Z* and the abutment is free to move within the limits of the slot in the synchronising ring. Therefore, the ring can be compressed and the sliding sleeve moved over into full engagement. The action of the force on the split ring is such that the higher the load imparted to the sliding sleeve, the greater the friction force existing between the cone faces, so that faulty engagement of the gear is impossible.

Two other gearboxes in the Meadows range incorporate the Porsche synchromesh mechanism, namely, the 350 C.S.5 and 450 C.S.5 units, in which all the gears are in constant mesh. The 350 C.S.5 box has a maximum input speed of 2500 r.p.m., and a maximum torque of 350 lb-ft, and the gear ratios are as given below.

Gear	Overdrive	Underdrive
5th	0·798 to 1	1 to 1
4th	1 to 1	1·555 to 1
3rd	1·78 to 1	2·75 to 1
2nd	3·38 to 1	4·77 to 1
1st	6·13 to 1	7·68 to 1
Reverse	6·13 to 1	7·68 to 1

On either side of the box is a power take-off designed to transmit up to 30 h.p. at 1000 r.p.m. for a maximum of two hours. The specification is similar to that for the 250 C.S.5 gearbox, except the main shaft, which is of case-hardened E.N.25T nickel chrome molybdenum steel.

The maximum input speed and torque for the mark 450 C.S.5 gearbox are 2000 r.p.m. and 450 lb-ft, respectively, and the dry weight is 430 lb. A power take-off, designed to transmit 30 h.p. for a maximum of two hours, at a layshaft speed of 900 r.p.m., is provided, and the gear ratios are as tabulated below.

Gear	Overdrive
5th	0·72 to 1
4th	1 to 1
3rd	1·91 to 1
2nd	3·35 to 1
1st	6·98 to 1
Reverse	6 to 1

There are a number of differences from the specification given for the 250 C.S.5 box. Aluminium alloy to B.S. 1490 specification Lm 4-M is used for the casing and both the main shaft and the layshaft are of case-hardened E.N.39 nickel chrome steel, while for the gears E.N.36 nickel chrome steel is used.

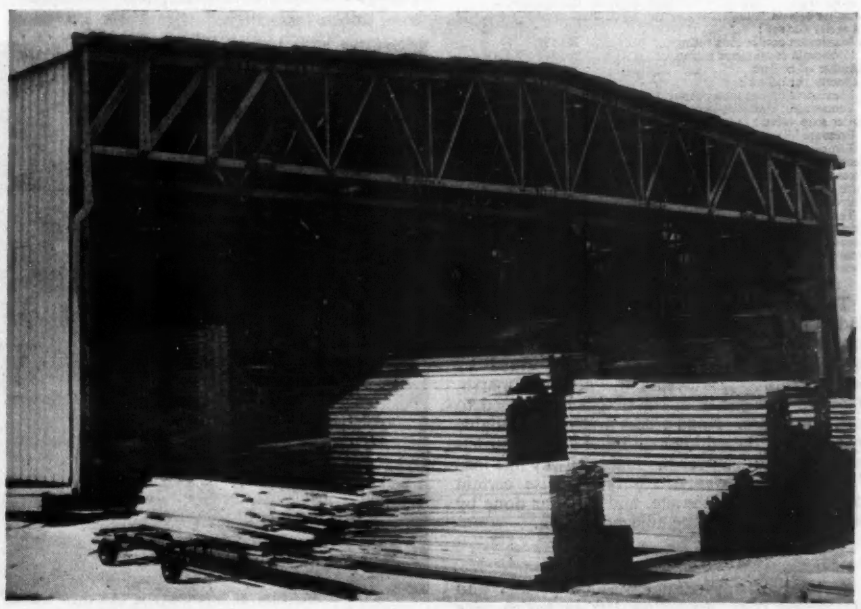
Timber Storage Shed

The accompanying illustration shows a shed of 106ft 8in span built with structural timber, which has recently been erected by Beves and Co., Ltd., at Shoreham, to the designs of the Timber Development Association. At present one of the main aims of the Association is to promote the structural use of timber, and several structures of a similar nature have been erected. In fact the shed illustrated is the third at Shoreham, and its design embodies certain improvements over the earlier ones.

The aims behind the present design were principally to provide the maximum unobstructed floor space with a clear height of 25ft, and to give complete freedom in using the space enclosed and also in extending the shed, either longitudinally or laterally, as required. At present two spans, covering 23,000 square feet, have been built, on a new site which it is planned to develop comprehensively over a ten-year period, so that ultimately 91,000 square feet will be built, together with a new wharf and other facilities for handling and storing timber.

The form of the main truss is clearly shown in the illustration. Stress-graded timber, mainly Douglas fir, has been employed, and split ring connectors used at the joints, which are bolted with steel accessory jointing members as necessary. The use of steel has been more extensive than in earlier work, at joints and other details such as the column bases. The columns are 26ft 8in apart (the whole site is laid out on a 40in module) and carry girders between them, on which alternate trusses are supported.

The columns are fully rigid at top and bottom, and provide resistance to horizontal loading. This avoids the provision of bracing members which might interfere with the work going on in the shed, and, in particular, members such as the "knee-brace" of earlier portal-framed trusses were considered undesirable for that reason. However, the truss is very stiff in relation to the column (the column consists of a double timber, as shown on the right hand of the illustration), and the dual advantages of a column head "fixed" as regards its slope, and of a simply supported truss above it, were achieved by capping the column with a short cantilever comprising a double-channel of structural steel, on which the truss is carried. These cantilevers can also be seen in the illustration. The relative stiffness of the three components—truss, steel cantilever, and column—is such that the truss behaves as if simply supported and the column as a strut "encastré" at top and bottom. Incidentally, the change in panel shape in the two outer panels at each side of the truss is a practical device to simplify the joints and allow the use of smaller timbers.



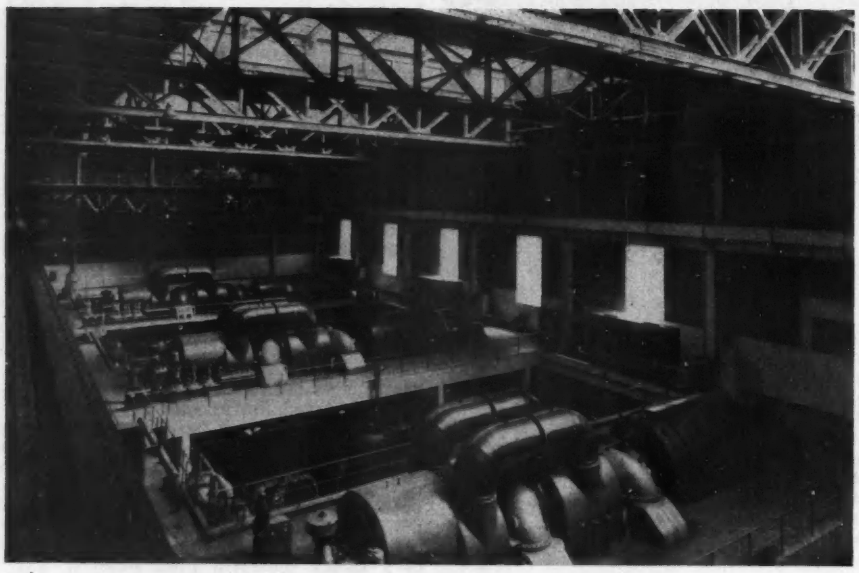
The timber trusses of the shed shown here have a clear span of 106ft 8in and are spaced 13ft 4in apart

Fleetwood Power Station

On September 14th, the official opening of Fleetwood power station took place. The station is at present equipped with three 30MW turbo-alternator sets, each with an economic rating of 24MW. Each of the three boilers has a capacity of 300,000 lb per hour at 615 lb per square inch and 865 deg. Fah.

THE planning of Fleetwood power station dates back to 1948, when the British Electricity Authority, now the Central Electricity Authority, took over from Blackpool Corporation the work of constructing a new power station in the Fylde area. Since no site could be found with sufficient cooling water for direct cooling, it was necessary to employ cooling towers. Reinforced concrete pile caps were constructed on top of the piles to carry the building columns, turbo-alternator blocks and boilers. The remainder of the basement floors are of beam and slab construction, spanning between pile caps.

The buildings are of steel-framed, brick-panelled design, with reinforced concrete cast-in-situ floors. A total of 3400 tons of structural steel was used.



Turbine-house, showing the three 30MW turbo-alternators

Eventually, the present situation, on the site of a disused sinter pond adjacent to Fleetwood Docks, was decided upon.

The station covers approximately 50 acres, and has been laid out for an ultimate capacity of 180MW, of which 90MW have so far been installed.

Fleetwood Power Station

Station area	49·6 acres
Sidings	10·2 acres
Ashing area	64·5 acres
Number of sets	3
Capacity per set :	
Maximum continuous rating	30MW
Economic continuous rating	24MW
Number of boilers	3
Capacity per boiler :	
Maximum continuous output	300,000 lb/hr
Economical continuous output	240,000 lb/hr
Boiler stop valve :	
Pressure	625 lb/in²
Temperature	865 deg. Fah.
Feed temperature at economiser inlet	360 deg. Fah.
Precipitator efficiency	97·5 per cent
Turbine stop valve :	
Pressure	600 lb/in²
Temperature	850 deg. Fah.
Vacuum at economical rating	28·7in Hg
Speed	3000 r.p.m.
Steam rates (economical rating)	8841 lb/kWh
Heat rates (economical rating)	9963 B.Th.U./kWh

The subsoil consists of sand, gravel and silt, and is of a variable nature, necessitating piling for all the major works. The ashing area covers approximately 64 acres, and was formed by constructing bunds across the adjacent marsh, the sand and silt from the marsh being used to form the bunds. Road access was made available by surfacing the ashing area bund and constructing a road bridge over the main railway line into Fleetwood. It was necessary to raise certain low-lying areas of the site, and this was done by pumping sand from the adjacent marsh.

Structural Work

A total of approximately 4000 precast and prestressed piles, averaging 25ft in length, was used to support the main buildings and the cooling towers.

Granolithic finishes have been laid on the basement floors, whilst the turbine and boiler operating floors are tiled.

The turbine-house and boiler-house roofs are of precast sections, laid in position, screeded and asphalted. "Lenscrete" glazing is provided in the turbine-house roof, whilst the boiler-house roof is fitted with power-operated opening louvres in addition to the conventional glazed roof lights.

The major ancillary building is the administration block, which houses the main switchgear, control and relay rooms, general offices, laboratory, canteen and first-aid room. This block is connected to the turbine-house by a bridge.

Additional ancillary buildings comprise the cooling tower make-up pump-house, reservoir pump-house, ash pump-house, sewage handling plants, tippler house and fuel oil pump-house. These buildings are framed in steel or in reinforced concrete, with brick cladding similar to the main building.

Electrical wiring for lighting and heating in the administration block is carried in ducts formed in the roof and floor slabs during the initial pouring.

Chimney

There is one chimney to serve the three boilers at present installed. This chimney is 300ft high, with an internal diameter at the top of 16ft. It rests on a supporting slab 8ft thick, which is founded on 176 piles, the total load on the piles being approximately 8000 tons. Two cooling towers have been constructed, each 250ft high, and built on 800 piles, each bearing a load of 25 tons. This is the first British station to use 100 per cent sea water for condenser cooling. Owing to the use of sea water, sulphate-resisting cement had to be used to minimise the risk of disintegration caused by chemical reaction between sulphates in the sea water, which is used in the circulating water system, and tri-calcium aluminate present in ordinary Portland cement. Each tower pond has a capacity of 1,150,000 gallons, and each tower is designed to cool 3,000,000 gallons of circulating water per hour, through a range of 14·8 deg. Fah.

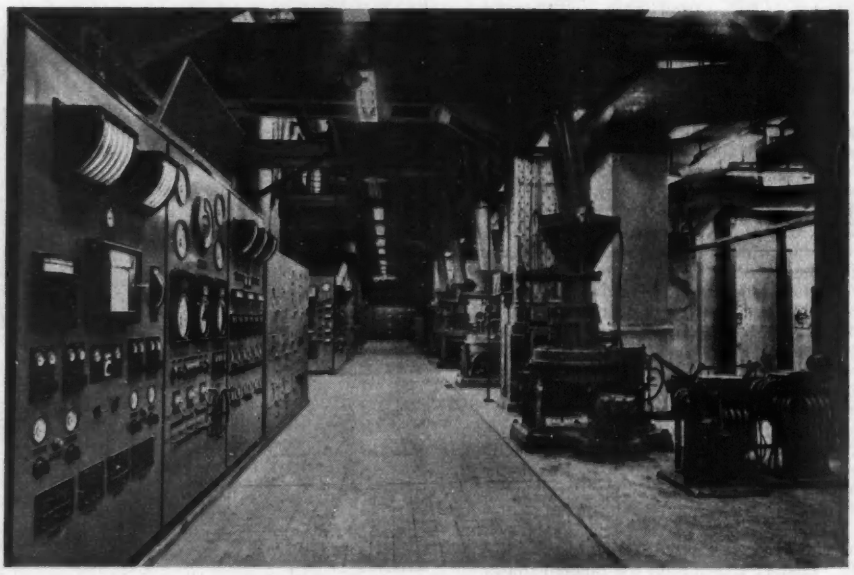
Turbo-Alternator Plant

The turbo-alternator plant consists of three 30MW sets, each with an economic rating of 24MW.

Each turbine has two impulse reaction cylinders, the high-pressure cylinder comprising twenty impulse stages arranged for single flow, and the low-pressure cylinder comprising twenty reaction stages arranged for double flow.

The turbines are directly coupled to the alternator, and run at 3000 r.p.m. The alternators are air-cooled and have direct-driven exciters. Operating steam conditions are 600 lb per square inch gauge, with an inlet temperature of 850 deg. Fah. Steam is exhausted to twin two-pass condensers, with a design vacuum of 28·7in Hg at 24MW, with cooling water at 65 deg. Fah.

There are two electrically driven extraction pumps per machine, each capable of handling the full quantity of condensate. Steam jet ejectors are used for extracting air from the condensers. There are two ejectors per set, each



Boiler control panels and coal feeders

capable of 100 per cent duty, together with a quick-start ejector. Two low-pressure and two high-pressure feed water heaters per set are employed. The final feed water temperature is 360 deg. Fah. at 30MW. Two shunt deaerators are provided, each with a capacity of 65,000 lb per hour. One deaerator is capable of serving two sets.

Five of the 330,000 lb per hour boiler feed pumps are electrically driven. There is also one steam turbine-driven standby pump for each set, with a capacity of 165,000 lb per hour.

Boiler Plant

Three pulverised fuel fired boilers have been installed, each with an evaporative capacity of 300,000 lb per hour of steam at a pressure of 625 lb per square inch at 865 deg. Fah. Two of these (No. 1 and No. 2) are of the Simon-Carves

Control room

tri-drum design, whilst the third is a Foster Wheeler single-drum boiler.

Self-draining superheaters are installed on all three boilers, the first two boilers having "Melesco" and the third "Foster Wheeler" superheaters. Nos. 1 and 2 boilers are each served by three "Lopulco" suction pulverising mills, whilst No. 3 boiler is served by two Foster Wheeler pressure design ball mills. Howden-Ljungstrom rotary air heaters are used throughout.

Draught is obtained by the use of two forced draught and two induced draught fans per boiler, whilst pulverised fuel is supplied to the furnace by exhauster fans on Nos. 1 and 2 boilers and by primary air fans on No. 3 boiler. All fans are driven by means of hydraulic couplings in order to obtain variable speed.

Automatic control of each boiler is effected by means of Bailey pneumatic equipment, and Kent equipment is installed for superheat control.

Dust is removed from the flue gases by means of electrostatic precipitation.

Coal Handling and Ash and Dust Disposal

The coal supplies are entirely rail-borne, and the weekly coal consumption at the station is approximately 3000 tons, at a load factor of 40 per cent.

Coal is unloaded by a single side discharge tippler with a capacity of twenty wagons per hour, built for a maximum wagon capacity of 20 tons. A single line belt conveying plant conveys the coal from the tippler to the boiler-house bunkers. The system is capable of handling 200 tons per hour, and there are three bunkers, each with a normal capacity of 500 tons.

A stocking-out tower provides for screened coal to be placed on stock, or reclaimed as required. The coal stocking ground has a capacity of 77,000 tons when the coal is 15ft deep, and the reclaiming system can operate up to a radius of 500ft from the tower.

Furnace ash and precipitator dust are conveyed by water in a low-pressure sluice to the ash discharge pumps, from which they are pumped through a pipeline 1500ft long, to the ashing lagoons. The ash and dust settle in the lagoons whilst the water is filtered and drained away to the estuary.

Circulating Water and Boiler Feed

Condenser cooling water, which is entirely sea water, is circulated between the station and the cooling towers, through reinforced concrete culverts. One circulating water pump is provided per set. Each pump has a capacity of 25,000 gallons per minute. The cooling system is made up by drawing water from the adjacent Fish Dock. When this is impossible, due to dock level, water may be drawn from the storage reservoir specially formed for this purpose.

An automatic intermittent chlorination plant is used to treat the condenser cooling water. It injects a chlorine solution into each condenser inlet in turn, the sequence being controlled by a master programme clock. The plant is capable of delivering 6000 lb of chlorine in twenty-four hours.

Feed make-up water is supplied from the town's main to a base exchange softener having a capacity of 6000 gallons per hour, and is then pumped to two evaporators of 2500 gallons per hour capacity.

Two tanks are installed for storage of town's water, one for storage of sea water and six surge tanks for storage of feed water. The tanks are contained in one bay at the top of the boiler-house, the indication of levels being available on the boiler operating floor. The tanks are of welded steel plate construction, and of 10,000 gallons capacity each, with the exception of the sea water tank which is of 8000 gallons capacity.

Ancillary Equipment

The turbine-house crane has a span of 87ft and has been designed to lift up to 75 tons with the main hook and 10 tons with the auxiliary hook.

The main workshop has a floor area of 3572 square feet, and is served by an overhead travelling crane of 15 tons working load. Its equipment includes a 12in and a 6in lathe and various other machine tools. Separate rooms are annexed to the main shop, and contain facilities for welder, blacksmith, joiner and electrician. Housed in the same block are the main stores and all necessary amenities.

Transformers and Switchgear

The generators are connected to 33kV busbars via 36MVA, 34·5/11·8kV generator transformers, which are provided with on-load tap changing.

There is no grid connection at Fleetwood. Surplus power is transmitted to the grid via the 33kV feeder system of the North Western Electricity Board.

The main 33kV switchgear is of the 750MVA horizontal draw-out, metal-clad design, with duplicate condenser busbars and plug change. The fault level has been limited to 750MVA with four generators connected, by the use of a 12·5 per cent on 45MVA cast-in-concrete reactor connected between the two halves of the four-section switchboard.

Each boiler/turbine unit board is supplied by its own 3MVA, 11·8/3·45kV transformer. These transformers are directly connected to the alternators. Central supplies, for starting up purposes, are available from two 6MVA, 33/3·45kV station transformers. The necessary unit switchgear is mounted on the operating floors adjacent to the plant it controls.

For supplying the high-powered auxiliaries, 3·3kV, 150MVA air-insulated, truck type switchgear is used. Low-powered auxiliaries use 415V, 25MVA switch and contactor gear. All motor circuits are controlled by contactor gear backed up by H.R.C. fuses.

Control and Relay Rooms

Both control and relay rooms are situated in the administration block, remote from the main buildings, but connected to the turbine-house by means of a bridge.

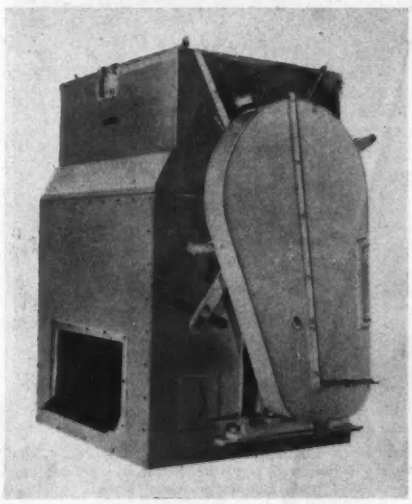
The generator remote controls are situated on the central control desk in the control room, and the relay panels containing all the protection relays for generators, station transformers, feeders and busbars, are installed in a separate room.

Main Contractors

Civil engineering consultants, L. G. Mouchel and Partners, Ltd.; site and structures, M. J. Gleeson, Ltd., J. Gerrard and Sons, Ltd., Fred Mitchell and Sons, Ltd.; Nos. 1 and 2 boilers, Simon-Carves, Ltd.; No. 3 boiler, Richardsons Westgarth (Hartlepool), Ltd.; ash and dust handling plant, coal handling plant, Simon-Carves, Ltd.; turbo-alternators, The English Electric Company, Ltd.; other electrical plant, The English Electric Company, Ltd., The British Thomson-Houston Company, Ltd., Metropolitan-Vickers Electrical Company, Ltd., and others.

Soap Amalgamator

A new soap amalgamator, Mark A2, is now in production at the works of Henry Simon, Ltd., Cheadle Heath, Stockport. It is claimed by the manufacturers that the new unit, of which we reproduce a photograph and which is of the bottom discharging pattern, is outstanding for ease and speed of operation. Our illustration shows that the equipment is of compact appearance since the whole of the mechanism, including a 5 h.p. a.c. geared motor, starter and the heavy duty chain drive, is enclosed in light sheet steel panels. A stainless steel lining is fitted to the mixing chamber, which is constructed of welded



Mark A2 soap amalgamator, showing driving side and delivery chute

mild steel, while the nickel plated steel mixing blades and shaft are mounted on bearings isolated from the chamber. Large "Perspex" observation panels are incorporated in the feed doors which, when shut, rest on micro-switches which prevent the mixing blades from rotating when the doors are open. A control bar which runs the length of the machine and is easily accessible to the operator actuates the discharge gate: the mixing chamber can hold 2 cwt of soap mixture having a density of 16 lb per cubic foot.

Scottish Roads.—The British Road Federation's most recent booklet draws attention to the condition of the road system in Scotland. The booklet is entitled "Road Matter: Scotland," and is published by the Roads Campaign Council, 15, Dartmouth Street, London, S.W.1. It illustrates congestion and inadequacy on Scottish highways by a number of photographs and by a pungent commentary.

Block Signalling Instrument of Unit Construction

A NEW block instrument which has been introduced into service on the London Midland Region of British Railways is shown in the accompanying illustrations. In issuing particulars of this instrument it is pointed out by the Region that the desirability of introducing a modern block instrument which would fulfill all block signalling requirements, and incorporate up-to-date instrument design principles, with a clean, functional appearance at an economical cost has been evident for some time.

The retention of instruments of the former constituent companies' patterns by re-servicing, has given little opportunity for such development. But owing to the extensive introduction of block instruments to replace block bell signalling on the London Midland, Eastern and North Eastern Regions, it has been necessary to manufacture block instruments on a comparatively large scale, and this opportunity has been taken to produce an entirely new instrument.

Unit block instrument arranged for "up" and "down" line working, with permissive commutator unit in position

The new block instrument is of unit construction and its design enables a complete instrument to be built up as required into single or double needle instruments for absolute or permissive working by the assembly of separate units. These comprise a bell and tapper key unit, a commutator unit and block needle indicator units. Each unit is complete and self-contained and positive inter-unit fixing is obtained by a simple interlocking means and securing screws which also serve as electrical interconnectors, ensuring correct electrical connections throughout the instrument.

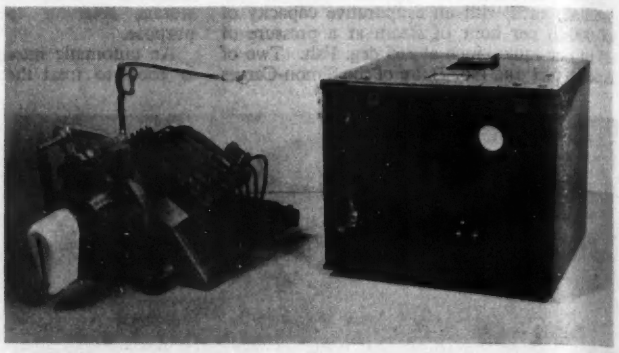
A disadvantage of the existing designs of block instruments has been the necessity to stock separate up and down instruments, not only for new works, but also for replacement under maintenance. With the new unit construction, the stocks can be kept to a minimum with the additional advantage that replacements of complete instruments or individual units can be made in the minimum of time and without the necessity of supervision or circuit checking.

Multi-way plug-sockets are provided on commutator and on bell and tapper key units, the external wiring being terminated with multi-way plugs. To connect the instrument to the external circuits it is only necessary to insert the plugs in the sockets which also incorporate clamping screws to grip each plug prong,ensuring electrical continuity and positive location of the plugs in the sockets. The multi-way plug in the commutator unit is also interlocked with the case door which is secured by a Yale lock, thus complete security is obtained. These points in the electrical and mechanical construction contribute to ease of installation and replacement of the whole instrument, or of any unit comprising the instrument with complete security and integrity of electrical connections.

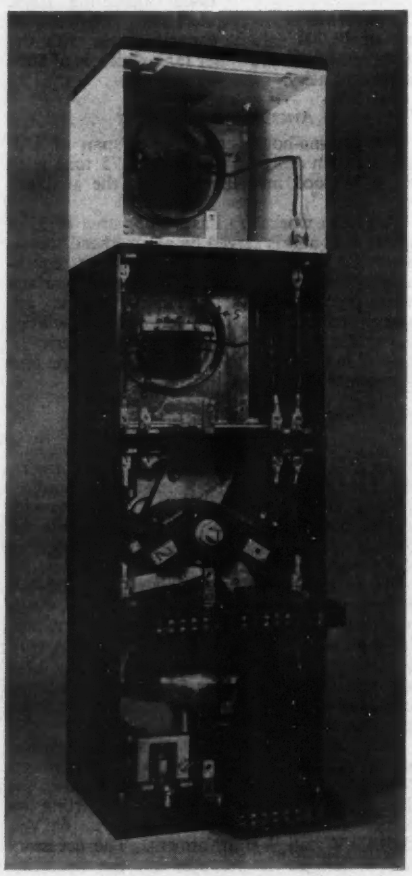
All of the units are fitted in identical moulded plastic cases which can be suitably adjusted to produce the specific requirements, for containing the bell, commutator or indicator assemblies. The moulded cases are black, except for the indicator unit energised by the commutator of the corresponding instrument at the opposite end of the section, which is cream in colour.

The commutator unit incorporates sufficient circuits to cover Welwyn control, interlocking block as in use on the London Midland Region, approach control of points and level crossing arrangements. Provision is also made for full commutation from a single block battery should this be required.

The bell and tapper key, commutator, and indicator mechanisms are completely self-contained sub-assemblies, which can be assembled and tested before being placed in their respective cases. The bell and tapper key movement is designed for fast bell signalling whilst bell domes are supplied in contrasting tones, being suitably identified and interchangeable. Absolute and permissive commutator units are available, the "line clear," "normal" and "train on line" segments of which always agree with the corresponding segments on the indicator dial. The units can be supplied with "line clear" on the left and "train on line" on the right, or vice versa. The permissive unit is similar in every way to the absolute unit except that provision is made for nine trains to be recorded and incorporates an escapement movement, which checks the signalman, when rotating the commutator, from recording more than one train at a time, either in or out of section. The commutator spindle is carried in self-lubricating bearings and moulded plastic contact segment holders, and spring contact seating blocks carry the contact segment and contact springs.



Unit block instrument commutator prewired ready for assembly into case. The escapement wheel and pendulum used for permissive working can be seen



Interior of unit block instrument showing plug connectors

The indicator mechanism is a self-contained sub-assembly carried on a pressed aluminium alloy frame. The movement comprises a small permanent magnet armature mounted on a phosphor bronze spindle and actuated by a single control coil carried on a moulded plastic former. The armature movement is protected from external magnetic interference by a screen of high permeability material. The needle indicator dials with their silk screen printed indication segments are interchangeable to enable them to conform to the type of commutator dials with which they will be associated.

Where both absolute and permissive working applies, the instruments are provided with hand operated reminder indicators which can display "absolute" or "permissive" and are fixed to the commutator and appropriate block needle indicator cases.

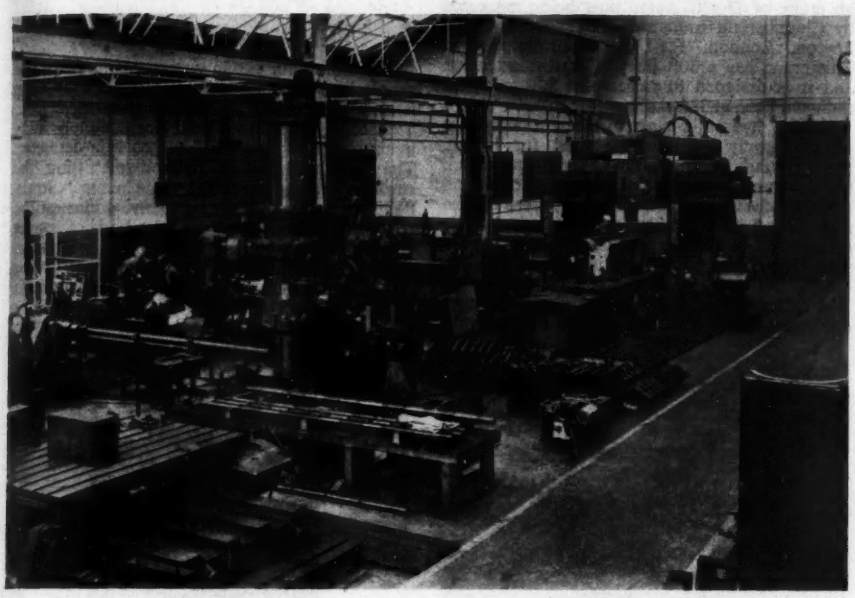
The design of the instrument, for which a contract has been placed with W. R. Sykes Interlocking Signal Company, Ltd., was directed by Mr. S. Williams, signal engineer to the London Midland Region.

SINGLE-STOREY CONCRETE FACTORIES.—The Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1, has published a booklet entitled "Single Storey Industrial Buildings," in which a considerable number of concrete buildings are illustrated and briefly described. They include examples of various systems of precast structures, shell construction, and factories with north light and monitor roofs.

Diesel Engine Manufacture at a British Locomotive Works.

New shops have been laid down at the Glasgow works of the North British Locomotive Company, Ltd., for the manufacture of M.A.N. diesel engines under licence. Engines ranging from 175 h.p. to 2000 h.p. are being built and a number of locomotives with these engines and Voith-North British hydraulic transmission are under construction for British and overseas railways.

WHEN a licence to build M.A.N. diesel engines in this country was acquired by the North British Locomotive Company, Ltd., some two years ago, plans were put in hand for the introduction of a new machine shop and engine assembly and testing facilities at the firm's Atlas works in Glasgow. Within a few months the new manufacturing facilities were completed and production was started on engines ranging from 175 h.p. to 2000 h.p. for locomotives, stationary and marine service. The immediate interest of the firm was naturally in engines for locomotive service, and as part of its plans in a large change-over from steam to diesel locomotive construction, it recently introduced a new range of standard diesel shunting locomotives of from 175 h.p. to 520 h.p., using Voith-North British hydraulic transmission. A number of these new standard locomotives of 225 h.p. are already in service and the orders in hand include twelve for the Scottish Region of British Railways. The firm is also building diesel freight transfer locomotives of up to 1000 h.p., as well as the diesel-hydraulic main line locomotives ordered under the British Railways' modernisation plan.



Part of heavy machining section at the top of the main workshop bay, with light machining bay on the left

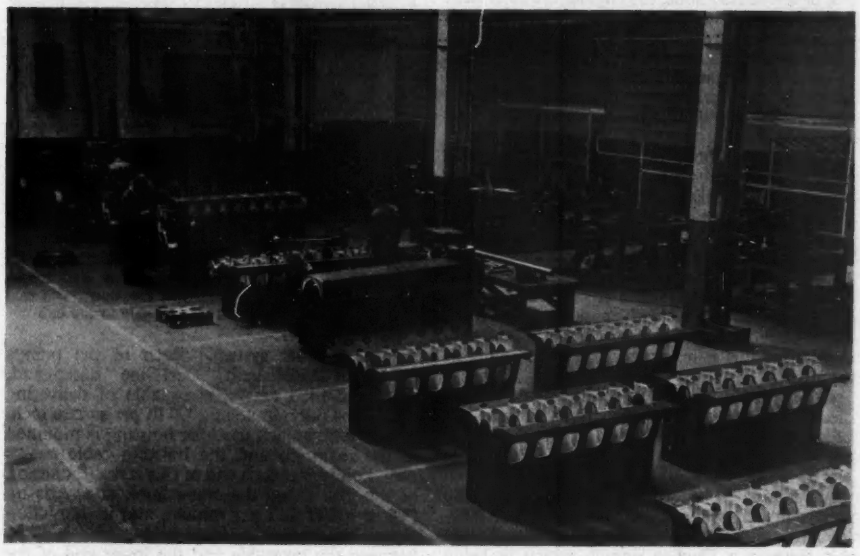
We recently visited the works of the North British Locomotive Company, Ltd., to see the new production lines for the M.A.N. engines, which, up to the present, have been equipped for the manufacture of three series of engines. The "W.V.17.5/22A" design in production is an in-line engine with six or eight 175mm bore by 220mm stroke cylinders, and developing between 180 b.h.p. and 440 b.h.p. at 1100 r.p.m., depending upon the number of cylinders and whether naturally aspirated or supercharged. The full M.A.N. range of this series includes three further engines with three, four and five cylinders, covering 90 h.p. to 175 h.p., and the British-built range will later be extended to include these smaller engines. The second design in production is the "W.V.22/30A" series. These are in-line engines with six or eight 220mm bore by 300mm stroke cylinders, and they can be arranged for natural aspiration, supercharging or supercharging and intercooling to give a power range from 390 b.h.p. to 1040 b.h.p. This series is also built in vee form with twelve or sixteen cylinders to give from 780 b.h.p. to 2080 b.h.p. The third series in production is the twelve-cylinder "L12V18/21" engine with a bore of 180mm and a stroke of 210mm, which, in its naturally aspirated form, gives 680 b.h.p. at 1500 r.p.m., or 1000 b.h.p. with supercharging.

For the manufacture of these diesel engines one of the old shops at Atlas works was rebuilt to provide an initial production area of some 25,000 square feet. This shop, parts of which can be seen in the illustrations on this page, comprises a main central bay and two side bays. The production flow is arranged down the length of the shop from the machine lines at one end to erection stations at the far end. A large test shop is situated immediately outside the end of the shop adjoining the erection section. Generally the engines are passed through the shop in batches of ten, but the layout and tooling provide a sufficient degree of flexibility to introduce engines required in smaller numbers, and individual components when necessary. At present some fifty engines are being produced per year, but the general production development programme is designed for an ultimate output of about 300 engines a year. In the initial plans due regard was paid to the probable necessity for extensions at some future date. For this reason the heavy machine section has been set at the end of the shop adjoining a large expanse of vacant land on which new buildings can be erected and equipped without interfering with current production flow or calling for major plant rearrangement.

In the initial work of planning the machine lines and the tooling for the three series of engines the wide use of interchangeable units in their basic design enabled plant requirements to be kept to a minimum. Each of the engines in a series is built up of generally identical components and the difference is only in the number of cylinders in a block and in the "long" parts such as crankshaft, camshaft, and piping. It has therefore been possible to design the main fixtures for machining the cylinder block to cover all the engines in a series up to the full length of the eight-cylinder models. The basic fixture beds which are used with clamping locations can be fitted with sets of units such as tool guides, support pads, clamps and bushes, in accordance with the number of cylinders in any batch of engines in hand. Likewise, the boring bars used for the main bearing housings and camshaft housings are made long enough to cover the maximum cylinder number requirements, and in them only the appropriate number of cutting tools need be fitted for the smaller engines in a series.

A point of interest in the use of these fixtures, is the means adopted to facilitate the selection of the correct units for each of the three series of engines in production when setting up a machine. All the jigs and fixtures for each individual series are painted in distinctive colours so that not only is much time and trouble saved in their selection and erection, but possibility of assembling the wrong units is avoided. A floor-operated, 10-ton overhead electric travelling crane serving the full length of the main bay handles all the heavy components and fixtures between the floor and the machines.

The main machining operations on the crankcase and cylinder block casting are carried out



Engine building line with sub-assembly benches on the right adjacent to the main component stores

on a Köllmann three-spindle, plano-milling machine, radial drills and a Graffenstaden travelling column horizontal boring and milling machine, situated at the top end of the main central bay of the shop. On these castings the first operation is the facing of the base and the machining of the upper main bearing block recesses along the full length on the plano-miller. The recesses are machined to very close limits as they provide the key references when positioning a block on all subsequent fixtures. With the casting then set on its base in another fixture all the machining operations on its sides and top are completed at one setting on the plano-miller. The second fixture serves only for location and clamping purposes and all the machining dimensions on a batch of castings are repeated by spindle settings with reference to the vernier optical setting means incorporated in the machine slides.

With the lower bearing blocks fitted the castings are set on the horizontal boring and milling machine where the end faces are milled and the main bearing housings and camshaft bores machined. The final operation on the castings is the machining of the cylinder lining bores on a radial drill. This machine has fitted on it a base locating fixture carrying units incorporating long pilot bushes for a cutter block set-up on the drill spindle. This set-up was originally intended for use in rough machining the bores and recesses, but the degree of accuracy and finish attained has rendered a second operation unnecessary. After cleaning and final inspection the cylinder blocks are transferred to an assembly storage area at the lower end of the shop.

Medium heavy parts such as cylinder heads, pump bodies and connecting-rods are machined in the bay on one side of the shop, and the smaller components in the bay opposite. Although the components produced are in many instances common to all engines the output required at present is insufficient economically to justify the use of special-purpose machines. For this reason the comprehensive line of machines installed is being used with a system of quickly interchangeable tooling and fixtures, which speeds setting and reduces idle machine time to a minimum. As new series of engines are added to the range manufactured new machines will be needed, and ample space has been left between those already installed for the introduction of new plant as required.

The component stores for the engines are situated at the lower end of the light machine bay adjacent to the engine building area. Lines of unit assembly benches are situated between the building area and the stores, and complete sets of components are batched and issued from the stores to these benches. As each unit is assembled it is tested and placed ready for the fitters on storage racks adjoining the appropriate engine erection stations. As can be seen from one of our illustrations, the engines are at present being built up in individual stations, but it is proposed to introduce a system of progressive assembly stations in the near future. When this is done the engines at the conclusion of each assembly stage will be transferred to the next station which will adjoin the appropriate unit storage rack.

Two further shops of the main works, which run parallel to the light machining and stores bay, have been allocated for diesel engine production and are in course of re-equipment. It is proposed to use one of these bays as a main stores, and the second as a fabrication shop for another series of engines having a welded steel cylinder block and crankcase. (Tooling for the fabrication of the welded crankcase used with the "L12V" engine is now complete and production of this component is being started this month.)

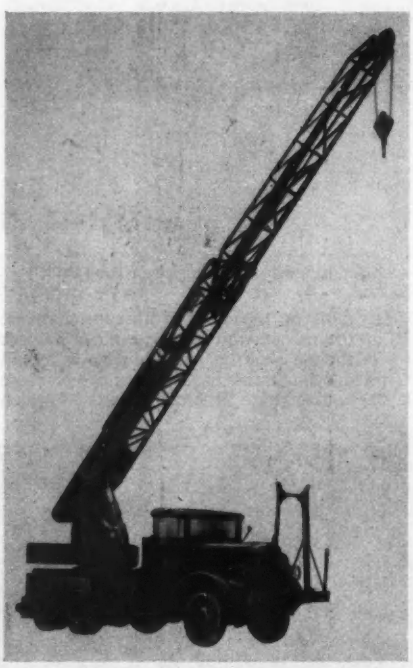
Concurrently with the development of this diesel engine production programme, there has been effected a reorganisation at the section of the firm's Queens Park works where the Voith-North British hydraulic transmission equipment is made, in order to comply with the increasing demand for this equipment for locomotives. Amongst the new plant installed in this shop is a Devlieg jigmill, which is being used for finish machining the main casings and has enabled a considerable reduction to be made in the production times for these units. The test shop has also been re-equipped with a double-ended dynamometer capable of testing equipment up to the largest capacity using two motors coupled together, or two smaller units at the same time.

A number of diesel locomotives are now in course of construction in the Queen Park works, and we had an opportunity to see the first of ten 0-8-0 diesel-hydraulic 855 h.p. transfer locomotives being built for the East African Railways. These metre-gauge locomotives have rigid frames and weigh 52 tons in working order. They are powered by the series "W.V.22/30 A" eight-cylinder engine with supercharging and intercooling, and the drive is taken through a Voith-North British "L37z" transmission having one converter and two couplings.

Hydraulically-Operated Truck-Mounted Crane

A HYDRAULICALLY-OPERATED truck-mounted jib crane of Dutch design now being marketed by Chamberlain Industries, Ltd., Staffa Works, Leyton, London, E.10, is illustrated below. This crane has a 30ft jib with a 10ft extension and it is designed to raise from 3 tons at 7ft radius to 1 ton at 38ft radius.

In the hydraulic system three independent pumps supply the pressure fluid for luffing, hoisting and slewing. The pumps are driven from a transfer case driven by a power take-off from the chassis engine. The pump used for the slewing and jib extension operations is directly driven from a shaft of the transfer case, and a second shaft drives the hoisting and the luffing pumps through sprocket wheels and chains. The luffing and hoisting systems can be interconnected in the event of failure of the hydraulic pump of either system. Each of the pumps used is of British built "Deri-Sine" design and, driven at 1450 r.p.m., is capable of delivering 22 gallons per minute at 2000 lb per square inch.



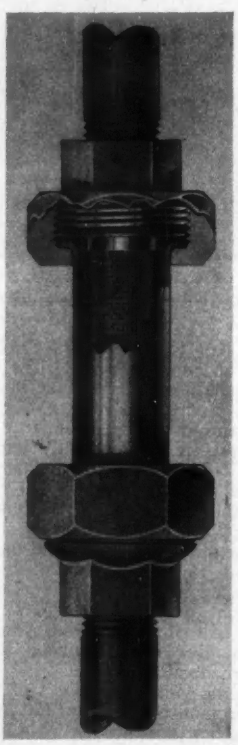
Truck-mounted, hydraulic jib crane with its 30ft jib extended to 40ft. The crane-operating and truck-driving controls are duplicated at the operator's and driver's seats, situated side by side in the cab

A hydraulic jack used for hoisting is mounted in the main jib and the hoisting cable passes round pulleys at each end of this jack. Extension of the jack raises the crane hook at speeds up to just under 50ft per minute, and its retraction lowers the hook. A large luffing jack is fitted between the turntable and the lower end of the jib and its hydraulic system incorporates an automatic unloading means to by-pass the fluid when the maximum elevating angle is reached. The slewing and jib extension motions are also actuated by hydraulic jacks and the two control valves for these motions are coupled in series so that both operations can be executed simultaneously.

To simplify control of the machine, the normal throttle, clutch, and brake pedals of the vehicle are duplicated so that the crane can be operated from the crane driver's seat, which is situated at the side of the vehicle driving seat but facing backwards. If necessary, the crane driver, from his seat, can use the duplicated truck controls to move the vehicle short distances, whilst steering with one hand. The crane controls are also duplicated at the vehicle driving seat. Outriggers, fitted with ratchet-operated struts, are fitted in the chassis of the vehicle. Crane motion speeds are controlled by the positioning of a main control valve in the hydraulic system, and four control levers are provided for operating the crane—one for luffing, one for hoisting, one for slewing, and one for jib extension.

Strainer for Pipelines

A STRAINER for use in water, steam, air or gas supply lines which is easy to install and maintain is now being made by Birfield Industries, Ltd., Stratford House, Stratford Place, London, W.1, in six sizes, for pipes from ¼in to 1¼in diameter. The construction and method of fitting the strainer, known under the trade name "Strait-flo," can be seen in the accompanying illustration. It consists essentially of a tubular body of copper which is fitted into the pipeline by bronze coupling nuts and the cylindrical mesh screen is held rigidly in the body by one of the couplings.



Mesh screen strainer for pipelines. The illustration shows how the cylindrical mesh screen is supported in the body of the strainer by one of the coupling nuts

The relatively long mesh screen provides a large cleaning area and its diameter is a little larger than the bore of the pipeline. The large annular space between the screen and the body of the strainer gives a free flow to the liquid or gas into the line. When it is required to clean the mesh the assembly is quickly and easily removed from the line by unscrewing the two coupling nuts. Standard screens are made of 40 by 40 mesh in Monel metal but alternative mesh sizes are available.

Diesel and Electric Locomotive Building in Lancashire

We recently visited the Dick Kerr, Preston, works of the English Electric Company, Ltd., and the Newton-le-Willows works of the Vulcan Foundry, Ltd., to see something of the activities of these firms since they joined forces in the manufacture of railway motive power plant. It was early in 1955 that the Vulcan Foundry, Ltd., became one of the English Electric group of companies, and a brief review of the history of this new member of the group may be of some interest.

The Vulcan Foundry was founded in 1830 by Robert Stephenson in collaboration with Charles Tayleur, a Liverpool engineer. Robert Stephenson was already managing a locomotive works in Newcastle on Tyne, but he was finding it very difficult to transport locomotives from his Newcastle factory to Lancashire for use on the newly constructed Liverpool and Manchester Railway. He decided, therefore, to go into partnership with Tayleur with a view to building engines on the spot, and a site was chosen halfway between the two cities, at Newton-le-Willows.

The first locomotive to be built at Vulcan Foundry was produced for the North Union Railway and was named "Tayleur," and it was followed shortly afterwards by three more for the Warrington and Newton Railway opened in 1831. Soon the firm was building locomotives for many of the new railways which were springing up in Great Britain and was establishing itself in the export market. By 1840 engines had been sent to no fewer than five Continental countries and even to the U.S.A.

In 1847, the Vulcan Foundry took over a subsidiary firm, the Bank Quay Foundry, which had been operating in Warrington since 1834. It was there that the materials for such enterprises as the Conway Bridge and the Britannia Bridge over the Menai Straits were prepared. The first iron seagoing vessel, "Tayleur," a tea clipper, was also built at Bank Quay Foundry. Locomotive building, however, remained the main activity, and among the famous locomotive engineers connected with the Vulcan Foundry were William Kirtley, H. Dübs, and Sir Daniel Gooch.

The firm's long connection with India began in 1852 with the export of eight 2–4–0 passenger locomotives to the Great Indian Peninsula Railway. These engines opened the first public railway in India, from Bombay to Thana in 1853, an event which was commemorated at the Indian Railways Centenary Exhibition at New Delhi three years ago. Between 1852 and 1952 Vulcan supplied nearly 2750 locomotives for service in India, an average of more than one a fortnight for 100 years. In 1871 Vulcan built the first locomotive to run in Japan. In the 100 years locomotives were also built for the Argentine, Burma, China, Egypt, the Gold Coast, Nigeria, Bolivia, Iran, Iraq and New South Wales, and many other countries.

Outstanding among the productions of the inter-war years were the standard locomotives for India. After building many of the earlier B.E.S.A. semi-standard engines, Vulcan played a large part in assisting the Government of India with their great standardisation drive in the 1920s, and subsequently large numbers of both the broad and metre-gauge types evolved were built at Newton-le-Willows.

During the second world war much of the design work for the Matilda tank was entrusted to the firm and subsequently nearly 3000 were either built at Newton or manufactured by other companies to Vulcan jigs and gauges and under their guidance. In 1943, however, production reverted to locomotives and 390 of the "Austerity" 2–8–0 locomotives were built to the orders of the Ministry of Supply for the use of the War Department.

Although most of the Vulcan Foundry's earlier history is concerned with the development of the steam locomotive the company has also been actively engaged for many years in other forms of motive power for rail traction. As long ago as 1928, the company was making mechanical parts for electric and diesel-electric locomotives. With the growing demand for the newer forms of traction after the war, a new section of the works was opened in 1948; it included a new erecting shop, a fabricating shop and a paint shop. From 1948 onwards, close collaboration was established with the English Electric Company, Ltd., in the manufacture of mechanical parts for electric and diesel-electric locomotives, until, early in 1955, the Vulcan Foundry, Ltd., and its associated company, Robert Stephenson and Hawthorns, Ltd., with works at Darlington and Newcastle upon Tyne, joined the English Electric group. Re-equipment is a continuing process at the Newton-le-Willows works, and during our visit we saw a new diesel engine test shop and a newly equipped machine shop. As it is now constituted, the group of companies has a total strength of about 5000 employees engaged exclusively in building railway motive power plant.

Among the locomotives that we saw under construction during the tour are a number of 2000 h.p., 3000V, d.c., 3ft. 6in gauge electric locomotives for the South African Railways They are B_o–B_o locomotives with a weight of about 83 tons and an axle loading of 21 tons. Complete locomotives are being built at Preston, while mechanical parts are also being built at Newton-le-Willows, to be fitted there with English Electric electrical parts.

A number of 1500 h.p. main line diesel-electric locomotives are being built for Malaya. They have a C_o–C_o axle arrangement and are powered by the English Electric "12SVT" diesel engine rated at 1500 h.p.

At Newton-le-Willows we saw some of the forty-seven 400 h.p., diesel-electric shunting locomotives that are being made for Holland. They are basically similar to the 400 h.p. shunting locomotives, several hundred of which are now operating on British Railways.

Opening of Dry Dock on the River Tyne

Last Friday, an opening ceremony took place at South Shields, when the Civil Lord of the Admiralty, Mr. Wingfield Digby, inaugurated the dry dock built for Brigham and Cowan, Ltd. The dock is shown in the accompanying illustration; it is able to accommodate a tanker of 38,000 tons, its principal dimensions being a length of 715ft, a width at the entrance of 95ft, and a depth of water over the sill at high water springs of 25ft. During the course of the various speeches accompanying the opening, the importance of dry-docking facilities of this size was emphasised, and it was claimed that the dock was the cheapest of its size constructed in this country. Its cheapness is due to the novel methods used in its design and construction—methods which were briefly described in The Engineer in our annual civil engineering review published on January 6th last. Briefly, the dock was excavated in a stiff clay; large precast concrete ribs weighing about 10 tons each were placed against the 40ft clay face, to form cantilevered buttresses. The floor and wall structure was then completed by *in-situ* concrete work. Upward hydrostatic pressure from beneath the floor of the dock is resisted by steel piles, of H-section, tied into the concrete of the floor and driven 45ft below it. Each of these piles carries a load of 30 tons in tension. The dock has an all-welded steel flap gate. The consulting engineers for this work were Messrs. G. Maunsell and Partners, and the contractor was Marples Ridgway and Partners, Ltd.

Technical Reports

Etude de la Lubrification sous Pression Rapidement Variable. By F. Charron. Publications Scientifiques et Techniques du Ministère de l'Air, No. 310. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price 450 francs.—Plastic lubricants in general consist of a disperse phase (which is optically anisotropic) in a viscous liquid. During the movement which occurs in a lubricating film, orientation phenomena take place which can be rendered visible in polarised light. In the tests which the author conducted, such lubricants were subjected to sudden strong pressures which caused flow in capillary tubes or between two parallel flat discs. The efficacy of the plastic lubricants under these conditions was determined.

Sur la Turbulence Spatialement Homogène d'un Fluide Compressible. By Maria Z. Krzywoblocki. Publications Scientifiques et Techniques du Ministère de l'Air, No. 314. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price 650 francs.—Many powerful approaches to the problem of turbulence have been made during the last decades, notably by A. Kolmogdroff, W. Heisenberg, L. Onsager, Th. von Karman, J. Kampé de Fériet, and others. Kampé de Fériet has applied the results of the theory of probability functions to the spacially homogeneous turbulence of incompressible fluids. He defined the motion of a spectral tensor within the framework of the theory of probability functions. The present work generalises these theories and takes the important steps of extending them to compressible fluids; correlation and spectral scalars and tensors are developed for this case.

Dry dock at South Shields. The precast concrete buttresses, incorporated in the later in-situ construction are clearly seen. To the right of the dock are the 30-ton monotower crane and a new platers shop

Industrial and Labour Notes

Iron and Steel

The Iron and Steel Board has stated that steel production in August averaged 340,600 tons a week, a figure which represents an annual production rate of 17,712,000 tons. Last year, in August, steel output was at an annual rate of 17,946,000 tons. August, of course, is the month when annual holidays affect production, and this year the output was affected still more on account of the overtime ban imposed by maintenance workers in the steel industry. Normal working was resumed in the second week of August, but the cumulative effects of the ban naturally influenced the month's results. Pig iron production in August, at 235,900 tons a week, was at an annual rate of 12,265,000 tons, compared with an annual rate of 12,282,000 tons in August last year.

The Board says that in the first eight months of this year, crude steel production amounted to 13,610,000 tons, compared with 13,030,000 tons in the corresponding period last year. In the second quarter of this year, consumers' and merchants' stocks of finished steel increased to 4,026,000 tons, and were about 500,000 tons higher than a year previously. A further comment by the Board is that steel consumption in the first half of this year is estimated to have been 6·4 per cent higher than in the first half of 1955. In the second quarter of this year, however, consumption fell slightly as compared with the first quarter, and, according to the Board, this is the first decline, except for seasonal reasons, since 1952. The slackening in the rate of increase in steel consumption, is attributed by the Board " to a lower level of activity in those sectors of the economy producing cars and steel consumer goods."

Iron and Steel Board's Annual Report

This week, the Iron and Steel Board has published its second annual report. It covers the calendar year 1955. A great deal of this report is inevitably taken up by statistical information which has already appeared in our columns. The report appropriately begins by pointing out that the United Kingdom's production and consumption of steel each expanded during last year by approximately 1,250,000 tons, which was almost double the average yearly increase in the post-war period. It goes on to say that it had been hoped to increase production by about 1,500,000 tons in 1956. No significant increase in exports is expected this year, so that the great bulk of any increase in home production will be available for the home market. But, the report adds, output in recent months has been less than anticipated because of the effects of the ban on overtime by maintenance workers.

The chapter dealing with the steel industry's development plans is an interesting one. It records that, during last year, the Board gave its consent to forty-five development schemes which were estimated to cost £67,500,000. The actual expenditure last year on development schemes was £58,000,000. The report notes that some development schemes were delayed by difficulties in obtaining materials and mechanical and electrical equipment, particularly control gear, and by labour difficulties in the first part of the year. Good progress has been made, however, at most of the sites concerned and important additions to capacity should become effective during this present year. The report goes on to say that plans for creating additional capacity much beyond 1958 are not yet complete though it is clear that substantial additions will become necessary. Preliminary consideration is being given to the matter in conjunction with the examination of the long term demand for steel, and certain major projects have already been approved since the end of 1955 or are now under consideration with the companies concerned.

The report explains that, following the Government's appeal in the summer of 1955 for curtailment or postponement of industrial capital investment, the guidance of the Board was sought by the industry which was itself of the opinion that, as the supply of steel was fundamental to the economy, there should be no interruption in proceeding with the steel development programme. The Board fully shared this view, and having ascertained that it was also shared by the Government, advised the industry that there should not, on these grounds, be any delay in submitting or approving proposals which were essential to maintain or increase steel production.

The Board and the industry have been giving special consideration to the development of home ore resources and to the extension of those types of capacity which had been thought to be inadequate. Consideration has also been given to replacing capacity which might soon become obsolete and for which no replacement has yet been proposed.

Engineering Wages

On Thursday of last week, the executive of the Confederation of Shipbuilding and Engineering Unions decided that it would make application immediately for a substantial wage increase for workers employed in the shipbuilding and engineering industries. This decision follows the resolution, in favour of a new wage demand, which was passed unanimously at the Confederation's annual conference last month. It will be recalled that a similar resolution was carried a few months previously at the annual meeting of the Amalgamated Engineering Union's national committee. The last wage increase in the engineering and shipbuilding industries was granted last February when skilled men were given a rise of 12s. 6d. a week, semi-skilled men 11s., and unskilled 9s. 6d. a week. It was stated on Monday that the Confederation had formally notified the demand to the two employers' organisations concerned—the Engineering and Allied Employers National Federation and the Shipbuilding Employers Federation—and had asked for meetings to be arranged.

Prices and Wages

At the annual general meeting of Kirkstall Forge Engineering, Ltd., last week, the chairman, Mr. R. F. Butler, spoke about the need for wage stabilisation. There came a time, he said, when the customer, who, of course, had the final say, revolted and just refused to pay any more ; he would either do without or go elsewhere where he could buy at an economical price. That time, Mr. Butler asserted, had now arrived.

Mr. Butler went on to say that every year the unions put in for an increase in wages, and each time one of their main arguments was that the cost of living had gone up and therefore unless they got an increase they would be worse off than before. Of course the cost of living went up, Mr. Butler commented, for what else could happen when wages all round had been raised, and bearing in mind that wages were so large a proportion of the production cost of any manufactured article. One of the main duties of the trade union leaders was to improve the position of their members, and superficially the extraction of higher wages from the employers might seem a good thing to the majority of their members. But, Mr. Butler added, there were many extremely intelligent trade unionists who must have realised by now that these constant increases had not in actual fact improved the financial conditions of their members.

If, Mr. Butler continued, the present level of wages could be stabilised now for two years, during that time competition would have forced down prices to such an extent that at the end of the two years the purchasing power of to-day's wages would be higher than it was to-day. To advocate and press through a policy of wage stabilisation, Mr. Butler observed, needed men of courage and vision who would be prepared to put up with a good deal of unpopularity until in, say, eighteen months the benefits of their policy would start to become apparent. If, however, the trade union leaders persisted in their wage claims and succeeded, their members, Mr. Butler suggested, would find that at the best they were no better off after all. Many would be worse off because costs would have risen so much that orders would be lost.

Overseas Trade

The provisional figures of overseas trade in August show that the value of United Kingdom exports was £253,400,000, which was nearly £13,000,000 less than in July. The Board of Trade has pointed out that export shipments are usually sharply affected by holidays in August, though this year the month of August contained twenty-seven working days. In July and August together, the average value of exports, £259,800,000, was 2 per cent below the monthly rate in the first half of this year, but 7 per cent higher than the monthly rate for 1955. Imports in August amounted to £322,300,000, or £2,000,000 more than in July. For July and August together, the average value of imports, £321,200,000, was 2½ per cent below the monthly rate for the first half of this year. With re-exports in August valued at £8,200,000, the excess of imports over total exports was £60,700,000, or £16,500,000 more than in July. The average deficit for July and August, £52,500,000, was £1,500,000 above the monthly rate for the first six months of this year, but almost £20,000,000 below the average monthly rate for 1955.

Agricultural Machinery Exports

The Agricultural Engineers Association has recently reported that following " a severe setback " as a result of the Chancellor's measures, the sharp decline in the sales of British agricultural machinery has been stopped. Export sales over the last six months have shown a small but " not insignificant increase " of 8·6 per cent. A factor of special interest, the Association says, is that agricultural machinery exports to Australia have increased by almost 50 per cent, and there are also notable increases in such markets as New Zealand and France. The Association considers that the outlook for the next twelve months is encouraging " especially in view of the rise in trade that is likely to take place with South America." But, the Association adds, " this new situation must not be viewed with undue optimism " for there is still no visible sign of improvement in home sales. The net effect of present developments, it is stated, is likely to be a reduction in stocks, which, the Association thinks, should help to place the industry on a firmer basis to face the increasing competition at home and abroad.

Clyde Shipyard Strike

At the beginning of this week it was stated that a " basis for settlement " had been reached in the Clyde shipyard dispute. Three weeks ago, about 5000 platers, caulkers, burners and welders began a strike, with the support of their union, when there was failure to reach agreement on a claim for a guaranteed minimum wage rate. The strike has inevitably led to other workers having to be laid off, and it has been stated that altogether about 10,000 workers have been idle.

Discussions between the Clyde Shipbuilders' Association and representatives of the Boilermakers' Society were resumed at the end of last week. After another meeting on Monday it was stated that a basis of agreement had been reached between the two sides, and that there was every reason to believe that a resumption of work would result. The statement added that, if there was good will on both sides, there was no reason to doubt that a permanent satisfactory settlement could be reached.

At the time of going to press with these notes, the terms of the settlement have not been made public, but a speedy resumption of work is expected. A spokesman of the Clyde Shipbuilders' Association said earlier this week that as work had been so badly delayed, the yards were now anxious to fulfil their commitments.

Scientific and Industrial Research in South Africa

BY OUR SOUTH AFRICAN CORRESPONDENT

THE following items culled from the tenth annual report of the South African Council for Scientific and Industrial Research are representative of research of general engineering and industrial interest in progress in South Africa.

Oil from Coal.—A study of some typical Fischer-Tropsch catalysts by means of gas absorption has been completed at the National Chemical Research Laboratory. In consultation with the South African Coal, Oil and Gas Corporation, Ltd. (Sasol), and the Fuel Research Institute, it has been agreed that catalyst research within the laboratory should be directed towards fundamental studies such as the mechanism of promoter action in Fischer-Tropsch catalysts. This work has been started. In addition to this work on catalysts, the study of the autoxidation of 5— methylnonane used as a model hydrocarbon, typical of those present in waxes from the Fischer-Tropsch process, has been continued.

Desalting of Mineralised Water by Electrodialysis.—This project has continued as the main commitment of the process division of the laboratory, and its scope has widened considerably. Following on the operation of the first pilot plant unit, a second contract was entered into with the gold mining companies interested in the development of the process. This contract was for assistance in the design and operation of a larger pilot plant to be erected at Welkom in the Orange Free State. The object of the project is to test out the process as a means of purifying the very large volumes of brackish water which are pumped daily from mines in the area. Staff was trained in Pretoria for the operation of the Welkom pilot plant, which came into operation at the end of August 1955, and which is illustrated herewith.

Concurrently, the smaller pilot plant in Pretoria continued to operate on a twenty-four hours a day basis for most of the year, and with the co-operation of manufacturers overseas, a variety of membranes was tested out in practice. Work on the development of membranes has proceeded very satisfactorily, and some have been prepared with characteristics as good as—and in some cases, better than—those available commercially. Studies of methods for characterising permselective membranes have continued.

Re-Use of Sewage Effluents.—Stringent purification is required if sewage effluents are to be made available for unrestricted re-use. Investigations of the further purification necessary for such unrestricted re-use have therefore been continued. The results obtained again stressed the superior bacteriological quality of effluents from vleis as compared with sand-filter effluent. Existing natural vleis in the Witwatersrand area have been found to effect excellent purification of effluents charged with organic material, ammonia and bacteria of sewage origin. The biological purification agencies operating in these vleis are under investigation in order to evaluate their application to the further purification of sewage effluent.

The Olifantsvlei was selected as the most suitable for this study. This vlei receives sewage effluent containing bacteria, organic matter, nitrates and ammonia. For most of the time, the effluent from the vlei was of high quality. A detailed study of the fauna and flora of the vlei was also undertaken. A preliminary report on this work has been prepared.

Studies at the National Physical Laboratory

The need for a training centre for nuclear physicists was met by the establishment, on April 1, 1955, of such a centre, and the staff of the laboratory has been strengthened by the appointment of a number of experienced nuclear physicists from overseas. Work on the cyclotron progressed to such an extent that it was possible to start the first test run during May 1955, three years and eleven months after work was started. For the greater part of this period the cyclotron group consisted of only five persons. Initially a twenty microampere beam of deuterous was accelerated to 4,000,000 electron volts and by the end of May this had been increased to 6,000,000 electron volts with a 200 microampere beam. The completed cyclotron is illustrated.

Geological Age Determinations by Mass Spectrometry.—The publication of age determinations on the uraninites of the Witwatersrand system has attracted considerable interest from both local and foreign geologists. The system is, however, geographically isolated and the study has therefore been extended to other important igneous rock intrusions. For this purpose a new ultra-sensitive mass spectrometer has been constructed. Age determinations have also been made on minerals from Southern Rhodesia, Swaziland and the Malay Peninsula.

Study of Surface Structures by Electron Microscopy.—The electron microscope was used extensively in a continuation of the investigation of the surface structures of plastically deformed metals and alloys.

In an effort to explain the large variations in wattage losses, transformer laminations manufactured in South Africa were studied with the aid of the electron microscope. Suitable experimental methods were developed, and interesting preliminary results, which indicate the formation of undesirable nitride structures in the steel, were obtained.

Heat Flow Through the Earth's Crust.—The quantity of heat flowing outwards through the earth's crustal rocks, per unit area, per second, is a geophysical datum of importance for the study of the interior of the earth. The heat flow may be found by measuring temperatures at various depths in a deep borehole and combining the temperature data with thermal conductivities measured on samples of the rock core from the borehole. During the year, suitable discs have been prepared for conductivity measurements, from the cores of four boreholes in the Southern Karoo, in which temperatures had been measured previously. In addition temperatures were measured in a borehole on the Far West Rand.

Vacuum Tube Construction.—In the course of constructing a new vacuum system, a Penning type of ionisation gauge was constructed and calibrated for the range 10^{-3} to 10^{-7}mm Hg. Similar gauges have since been constructed for other laboratories. Experiments have been conducted on the construction of gaseous discharge tubes which can be controlled by a magnetic field. These tubes would be useful in certain problems in automatic control.

For facilitating the design of vacuum tubes and electron guns, an analogue computer is being built to plot electron trajectories for a given electrode system automatically. When completed it will also be available for the solution of other similar problems, including the mapping of static fields.

Magnetic and Crystal Amplifiers.—In the course of designing magnetic amplifiers, it was discovered that formulæ given in the literature for optimum design were not applicable. Revised formulæ were developed.

Amplifiers using transistors are finding ever wider applications. Under South African conditions, however, the fact that the germanium resistor has a large temperature coefficient must receive particular attention. Arising out of studies undertaken in this laboratory, an amplifier using germanium resistors has been built having an amplification which is nearly constant from 15 deg. to 40 deg. Cent.

Studies for improving the high frequency characteristics for transistor circuits have also been carried out with some success.

Instrumentation.—A microphotometer has been designed to replace an existing instrument in an observatory. It will give improved performance and operate without batteries. The recording portion has already been installed ; the stabilised light source has been tested in the laboratory and has now been built into the instrument.

An instrument has been built at the request of the Bituminous Binder Research Unit for measuring the stresses in a road surface as the wheels of a motor-car pass over it. Horizontal and vertical stresses are measured simultaneously on a small " button " isolated from the rest of the road surface and attached to the instrument which is sunk below the surface. In order to

The pilot plant at Welkom, which is successfully desalting saline waters from the O.F.S. gold mines, as a result of research by the National Chemical Research Laboratory

measure the visco-elastic properties of bituminous road binders, an instrument has been designed and is near completion in the workshops.

At the request of the Maritime Research Unit an instrument is being developed for measuring the temperature and speed of propagation of sound at various depths in the sea. In the completed instrument both quantities will be recorded simultaneously as functions of depth. The instrumentation section has also devised a means of, and developed electronic equipment for, measuring the velocity of artificial hailstones.

Mechanical Engineering Research Unit

The period under review was marked by the concentration of research effort on problems on behalf of industry. Developments during the past year, however, have made it quite clear that the existing research facilities will have to be considerably extended.

Predeformation and the Plastic Properties of Metals.—The study of the influence of predeformation on the plastic properties of metals has been continued. A number of medium—and high—purity zinc single crystals of high perfection were grown, under a fairly high vacuum, from the melt in a special electric furnace in which it is possible to control both the temperature gradient and the rate of cooling very accurately. It was found that accurate control of these factors is essential if high-quality single crystals are to be produced. Single crystals having smooth surfaces and uniform cross sections were produced by the use of special "precision bore" Pyrex glass moulds.

A highly sensitive special tension-compression testing machine, for the mechanical testing of the single crystals, was developed and calibrated, and tension-compression tests, aiming at quantitative measurement of the Bauschinger effect in the single crystals produced, are now in progress.

Influence of Stress on Corrosion.—The susceptibility of a light aluminium-silicon alloy of casting grade to stress-corrosion cracking has been studied. This alloy is widely used in engineering applications, and it is felt that an assessment of its resistance to stress-corrosion cracking in solutions of varying concentration will be of practical importance.

Caustic Embrittlement of Boiler Plate Steel.—Work has recently been started on an investigation concerned with the phenomenon of caustic embrittlement of boiler plate steel. Caustic embrittlement in riveted boiler drums has been a major problem to industry for several decades, and though much work has been done on this problem, an acceptable explanation of the basic causes and mechanism of caustic cracking is still lacking. The testing programme involves the exposure of suitable steel specimens to caustic solutions of varying concentrations in an autoclave operating at typical boiler temperatures and pressures. Both stressed and unstressed specimens are to be investigated.

Fatigue of Metals.—Fundamental research, carried out on the effect of interrupted and alternating load for different test periods, as applied to specimens of Iscor En-45 spring steel in the annealed condition, revealed that rest periods of up to twenty-four hours have no effect on the fatigue life of the material. The investigation is being continued for greater rest periods.

On behalf of the South African Railways a detailed experimental analysis of the stress distribution in a short length of rail subjected to loading of varying eccentricity and obliquity was carried out to investigate the fatigue strength of rails in curves. Similar stress analyses were carried out on a long rail carried in a rail chair. The results obtained made possible the selection of a suitable fatigue loading programme to simulate the loading conditions that were found to occur in practice. A series of rail specimens is now being tested under different loading conditions in the 100-ton Amsler pulsating fatigue testing machine. Fatigue tests on Thermit welded rails have been started on behalf of the South African Railways, and investigations into the fatigue strength of welded drill rods are also in preparation.

The completed cyclotron at the South African National Physical Laboratory

Corrosion fatigue tests were carried out on aluminium alloy specimens in an attempt to discover the reason for the failure of aluminium alloy fan blades in a corrosive atmosphere. It was concluded that the material was markedly affected by the corrosive atmosphere and that the failure could be attributed to the combined action of corrosion and fatigue.

Rock Bursts in Deep Level Mining.—The investigation into the problem of rock bursts in deep level mines of the Witwatersrand, which was commenced in November, 1952, was continued.

Mathematical analysis of the stress distribution around excavations of different shape and size in a homogeneous, isotropic, elastic, continuous medium under gravitational forces is in progress. Stress analyses, using photo-elastic methods, are being prepared. A large loading frame to suit photo-elastic models and to apply variable vertical and horizontal loads has been designed and is being manufactured.

If the stress in the rock around an excavation and the strength of the rock are both known, it might be possible to predict the behaviour of the rock around the excavation. Consequently, compression tests on quartzite samples taken from various localities were carried out to determine the linear compression strength and elastic constants of quartzite. A device has been developed to ascertain the violence of rupture of the test samples quantitatively. The creep properties of quartzite are also being determined. In order to measure the change in stress in the solid rock around an excavation as the face advances, a strain cell has been developed and will be cemented into a borehole drilled about 50ft to 100ft ahead of the working face.

The configuration of the fracture zone around excavations at depth is being studied by making observations in places underground where failure planes due to excavations nearby can be detected. To supplement this information, laboratory studies are being made on the formation of fracture zones around slots of different shape and size in models subjected to suitable loading conditions.

Statistical analyses, based on the data of 614 bursts which occurred in a specific mine of the Witwatersrand during the years 1948 to 1953, were carried out with the aid of the mathematics division of the National Physical Laboratory, in order to determine the influence of different factors on the occurrence of rock bursts. It was found that the frequency distribution of bursts during the day shows a significant peak at blasting time. It was also found that the method of mining has a significant effect upon the incidence of severe bursts.

Destressing operations, which aim at causing the crushing of stope faces artificially, are in progress in a number of stopes of a mine on the Witwatersrand. The destressing procedure consists of drilling holes 10ft deep and 2ft to 5ft apart almost normal to the face, and blasting them weekly, in addition to the ore-breaking holes. The blasting of the destressing holes does not necessarily result in breaking ore, but in effect crushes the solid zone ahead of the face for a certain distance, thereby shifting the zone of high stress further back into the solid and creating a cushion of crushed rock between the dangerous, highly stressed, solid zone and the working place. The most efficacious method of destressing must be developed and, to ascertain this, the effects on a face of exploding known charges in holes of known depth and spaced at a known pitch, are being studied.

Gas Turbine Research.—Work on the development of a thermo-acoustic resonator in which pulverised coal will be used as a fuel, has been continued. The first experimental model operating on hydrogen as fuel has been built, and some preliminary tests have been conducted. Although tentative, these tests have shown the importance of the correct tuning of the elements of the thermo-acoustic resonator, and further work is now being done to determine to what extent the various design parameters affect its functioning.

The Measurement of Low Air Velocities.—The accurate measurement of low air velocities constitutes a problem which has an important bearing on studies of ventilation in buildings, and on boundary layer phenomena.

Several improvements have been effected on the 24in low-speed wind tunnel and, with the completion of the 5ft 6in whirling arm, an overall range of speeds between 3ft per minute and 100ft per second, is now available for instrument development.

New instruments at present under development include a centrifugal air manometer to be used with a special low resistance pitot tube, a sensitive liquid manometer with electromagnetic balance indicator, an instrument for measuring axial component of velocity, a pitometer with flow tube using "atomised" oil for speed indication, a miniature vane anemometer having an electronic revolution counter, and, finally, a hot wire anemometer operating either on direct or alternating current. The last two of these are to be used as standards on the whirling arm to measure the relative air velocity directly, thus obviating the necessity for predetermining the swirl velocities set up in the circular duct during the calibration of an instrument.

Glockner-Kaprun Hydro-Electric Scheme

No. II—(*Continued from page* 381, *September* 14*th*)

A major hydro-electric scheme in the Austrian Alps is described. It is a two-stage development with two seasonal reservoirs which permit about three-quarters of the net power output of 615 *million kWh annually to be generated in the winter. The total installed capacity is* 312*MW : pumping plant is also installed for additional peak load generation.*

THE contributions made by Austrian engineers to the study and construction of arch dams are probably not so well known in this country as those of their Italian and French colleagues. However, some interesting and original work has been done in Austria, with continued progress since the completion of the first arch dam in the country at Gerlos in 1944. The Glockner-Kaprun scheme illustrates this work particularly well, for it involved the construction of three such dams. The five main dams of the scheme are shown in Fig. 5 and listed with their principal dimensions in Table IV. Wasserfallboden reservoir is formed by a single dam, the largest in the scheme, at Limberg. Although designated an " arch gravity " design by its constructors, the cross-section shows by its slenderness that the arch effect is relied on for the great majority of its strength.

The upper reservoir is formed by two dams, one a gravity structure and the other a thin arch ; similarly the balancing reservoir of the Möll diversion needed two dams, a gravity and an arch. It may be observed that the Möll dam is of exceptionally slender construction.

The design of these dams has generally been a four-stage process. First a modified version of Ritter's approach to the trial load analysis is made, using only one cantilever to keep the computation as simple as possible. Having selected the final cross-section, a more elaborate trial load analysis is carried out in the second stage. Then the final design is investigated further in two ways, namely by loading concrete models and by photo-elastic analysis of " slices " of the arch. In the later work a more elaborate analytical method based on a tensor analysis, has been employed. The method is due to Dr. Parkus and is considered to be accurate, but involves long computations and the use of a calculating machine.

In the case of Limberg dam, the second, more comprehensive, trial load analysis was worked out for only one loading condition, namely the reservoir full and summer temperatures in the body of the dam. This condition is likely to be experienced in early autumn and gives the severest loading. A comparison between the results of this analysis and the comparable simplified calculation gave a basis for estimating probable errors in the results for other loading conditions analysed by the simpler method. The maximum compressive stress in Limberg dam calculated by the more elaborate procedure was estimated at 56 kg per square centimetre, and occurred on the water side at the 1660m level. The greatest calculated tensile stress at the base was less than 1 kg per square centimetre, and the maximum stress transmitted to the rock at the abutments was estimated at 35 kg per square centimetre. The ratio $E_{rock}/E_{concrete}$ was taken as 0·75. Reduction of the rock stresses was an important point in design and was achieved by gradually splaying out the cross-sections to give a thicker arch at the springing, as the plan Fig. 6 clearly shows for the crest of the dam ; arch sections at lower levels are geometrically similar.

The model research has been carried out at a laboratory at Kaprun, where investigations into permeability and the frost resistance of concrete have also been undertaken. The accompanying illustrations Figs. 7 and 8 show phases in the testing of a model of Drossen dam. The model was made from a concrete comprising kieselguhr, alabaster and water in the proportions 0·5: 1·0:1·1 and was 1 : 100 of the scale of the actual structure. The value of the modulus of elasticity *E* of the model was one-tenth of that of the concrete used in actual construction.

One point emerging from the photo-elastic studies is of interest by comparison with practice in other countries. It was established that relatively little difference occurred in the stress distribution near the edges of the dam if " fixed " or " hinged " ends were used for the tests. (This point was, of course, associated with the thickening of the dam at the abutments, mentioned above.) Thus an elaborate peripheral joint was not thought necessary, a trend which was explained, on the site, by the analogy that a door with a curved hinge would not open. Mooser and Drossen dams are shown in Fig. 10.

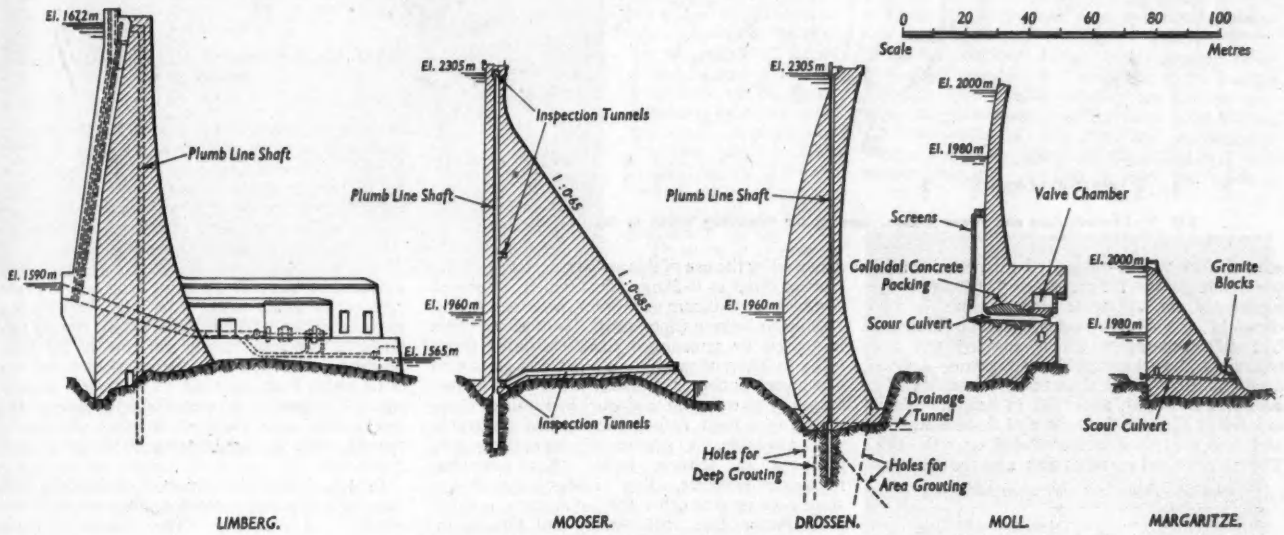


Fig. 5—Dams of the Glockner-Kaprun scheme

TABLE IV—*Dams of the Glockner-Kaprun Scheme*

Reservoir	Impounding dams	Maximum Height, metres	Crest length, metres	Radius, metres	Volume of concrete, cubic metres	Volume of excavation, cubic metres
Wasserfallboden ...	Limberg arch gravity dam	120	357	187·8 (at crown on centre line) 66·6 (at base on centre line)	446,000	122,000 (overburden) 165,000 (rock)
Mooserboden ...	Mooser gravity dam ...	107	470	425	670,000*	80,000 (overburden) 100,000 (rock)
	Drossen arch dam	112	357	199·65 (mean)	350,000	120,000 (overburden) 180,000 (rock)
Margaritze	Margaritze gravity dam ...	37	175	—	33,000	6,000 (rock)
	Möll arch dam	93	164	62·3	35,000	9,000 (rock)

* Including 150,000 cubic metres of facing concrete.

Researches in Concrete Technology

Design of the concrete mixes for the dams also required exhaustive investigations. The cement ropeways had been constructed during the war and were of limited capacity such that they governed the speed of the concreting programme. It was considered therefore that concrete with a cement content as low as possible, consistent with other requirements, should be achieved. In fact, the strength of the concrete was limited by the aggregate which has a laminar structure. The governing properties of the concrete were therefore largely frost resistance and impermeability. Some of the investigations into these problems was described last year at the fifth congress on large dams.* Details of the concrete as finally defined for the various dams are given in Table V and Fig. 9.

One of the main conclusions of the research at Kaprun was that a significant improvement in a concrete's frost resistance was obtained by eliminating the finest sizes of powder from the aggregate. This fact has, of course, been observed in similar work in other countries, and was referred to particularly in our description

* " Contributions Relating to an Increase in the Frost Resistance of Concrete," Paper R.51, by Dipl.-Ing. J. Fritsch ; and " Concrete with Low Cement Content," Paper R.50, by Dipl.-Ing. H. Böhmer and Dipl.-Ing. A. Wogrin.

of the French dams at La Girotte and Tignes, published in December, 1951. The main interest in the Austrian work, however, lies in the method used to eliminate the fine material, which is an innovation for this class of work.

Apart from the array of screening and washing plant, which would normally be expected on the site of a large dam for preparation of the concrete aggregates, the aggregate plant serving the two dams of the Mooserboden reservoir included hydraulic separators which enabled the fine material to be rejected. This apparatus—known as a "Rheax" vertical elutriator—consists of a pear-shaped vessel, about 3ft in height. Water is introduced near the base and flows upwards, and ungraded sand is introduced near the top. The coarser sand particles sink, and are extracted at the base, and the smaller particles rise with the water and run to waste, or to a lagoon for recovery, at the upper outlet. The size of particles thus rejected varies, according to the velocity of flow, following Stoke's law. It is claimed that a precise separation has been achieved by the use of this apparatus, into particle sizes of 0mm to 0·08mm (dust which is rejected completely), 0·08mm to 1·0mm (finest sand), and 1·0mm to 3·0mm (fine sand). Sand above 3mm is graded by screening. Each elutriator treats 60 kg to 80 kg of sand in an hour, and gives 4 to 9 per cent under or oversize. It is used in two stages to give the three sizes. At Limberg dam, which was built before this special apparatus was available, a degree of separation was achieved in settling tanks, thus removing micaceous particles. The "Rheax" system has since been used at other sites, in Austria, notably Ybbs-Persenbeug, Jochenstein, and Ottenstein. Its use and scope was described in a paper (12H/4) presented, in German, at the fifth World Power Conference by Messrs. Scholtis and Fritsch.

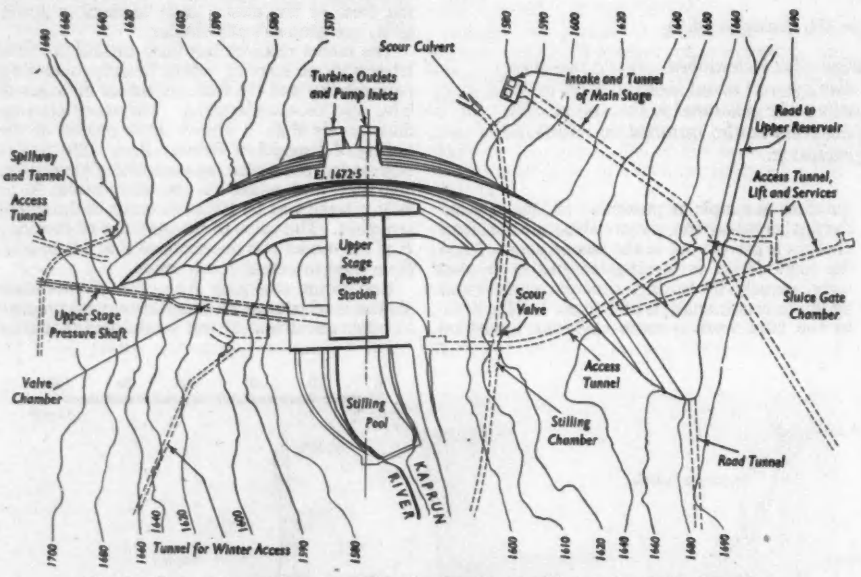


Fig. 6—Limberg dam and power station, showing the tunnelling works at the dam site

TABLE V—*Data for Concrete of Main Dams*

	Limberg dam	Drossen dam and facing concrete, Mooser dam	Hearting concrete, Mooser dam
Cement content, kg per cubic metre	250–260	235–250	135–150
Water cement ratio ...	0·55–0·57	0·48–0·54	0·75–0·88
Additive, as per cent of weight of cement	Plastiment 1 per cent	Frioplast ¼ per cent	Frioplast 0·6 per cent
Aggregate sizes, mm	0–3, 3–10, 10–30, 30–100	0·1–1, 1–3, 3–10, 10–30, 30–80, 80–120	As for facing concrete
90-day strengths :			
Tensile strength in bending, kg per square centimetre	46	48	32
Compressive strength, kg per cubic centimetre	310	360	204

Method of compaction : immersion vibration for 25·30 seconds.
Cement : Portland cement with low heat of hydration.

Some further information on the concrete research programme is given below, abstracted from the paper previously referred to by Messrs. Bohmer and Wogrin. Besides the essential requirements, viz. specified compressive and tensile strength, watertightness, low thermal conductivity and workability, the freezing resistance is the most important property of the concrete. Especially, heat generation must be kept low, so as to render unnecessary expensive installations for artificial cooling, which are not required if the generation of heat is controlled by a low cement ratio. By this, a twofold economy was possible. The authors call concrete which fulfills all these requirements a concrete of high quality. The extensive work on the freezing resistance of concrete in the laboratory owned by the Tauernkraftwerke A.G. resulted in the finding of certain rules, upon which further research was based. These rules concern the fine sand, the cement ratio, the source of cement, and the admixtures ; special attention was paid to the workability of green concrete. In Austria freezing tests are carried out by exposing the concrete cyclically to alternate freezing and thawing between −20 deg. Cent. and +15 deg. Cent. during cycles of 4, 8, 12, 4 hours, &c. The degree of freezing resistance is then evaluated by measuring the modulus of elasticity, determined for a specific load of 5 kg to 50 kg per square centimetre. The test slabs are 20cm by 20cm by 30cm in size, and are fifty-six days old. The concrete is considered frost-resisting, if its modulus of elasticity does not drop below 75 per cent of its initial value, after fifty freezing and thawing cycles. There were mainly tested two series of concrete, chiefly differing in the compositions of their sands. Series M had very fine sand, series P coarse sand. The cement content was 270 kg per cubic metre for both series. The workability was identical so that the water/cement ratio changed, being 0·55 for M and 0·50 for P.

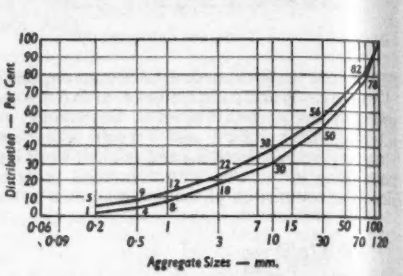
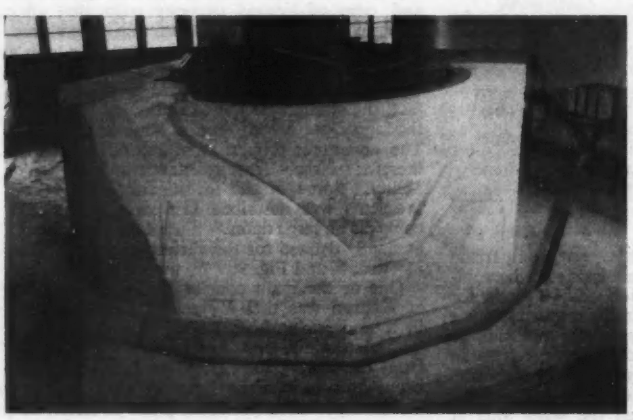
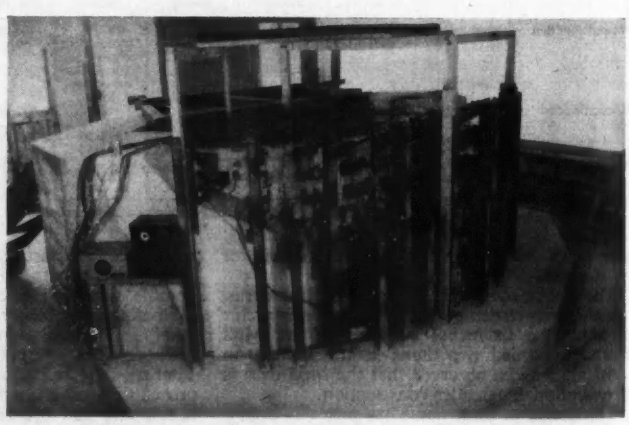


Fig. 9—Grading curve for aggregate of Mooser and Drossen dams

In Fig. 11(*a*) the number of freezing and thawing cycles are plotted against values of the modulus of elasticity. The inserted diagram depicts the size distribution of the sand for both concretes (0·06mm/0·09mm/0·2mm and 0·5mm are square, 1mm and 3mm are round apertures). The diagram shows that concrete with a high percentage of fine sand has no resistance to frost, whereas for concrete of coarser sand grading a freezing resistance is evident from the beginning. This also applies to concrete with a cement content of less than 270 kg. According to these findings the size groups of 0mm to 0·09mm are completely eliminated. The cement content does not influence the freezing resistance to a considerable degree. From Fig. 11(*b*) it can be seen that no improvement is gained in the freezing resistance of concrete by an increase of 140 per cent in the cement ratio. Contrary to





Figs. 7 and 8—Structural model of Drossen arch dam built to a scale of 1 : 100. (Left) the model dam is built on a bed of reinforced concrete. (Right) Load and strain measuring instruments are shown in position for testing the dam

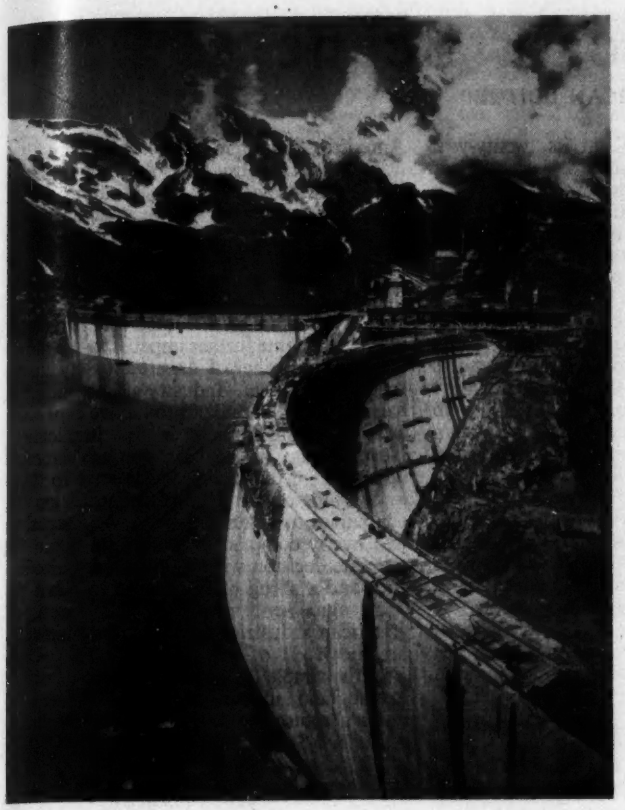


Fig. 10—The two dams of Mooserboden reservoir. The arch dam—Drossen—is in the foreground and the constructional plant on the Hohenberg is to be seen

present assumptions, the cement ratio is not of such importance and the tendencies for a minimum cement content follow. It goes without saying that the source of cement, i.e. the brand of cement, influences the freezing resistance and tests to ascertain the most suitable type of cement were carried out.

The removal of fines necessitates the admixture of an air-entraining agent ; further, the aggregates demanded such admixtures for obtaining the specified workability of the concrete. It was of great importance for the quality of the concrete that the additional plastifying effect of the air-entraining agent employed permitted a further reduction of the water content. The common notion was confirmed that the admixture of air-entraining agents are the most effective means for obtaining frost-resisting concrete, but with the reservation that the sand used is not too fine, thus enhancing or preventing the formation of the minute bubbles of air throughout the concrete. The functional effect of the admixture is only guaranteed by completely removing the dust particles of the sand. The important influence on the freezing resistance of concrete with small cement content of the admixture as such, and in connection with dust-free sand, may be seen from Fig. 11(*c*). The curve *a* is identical with curve *a* in Fig. 11(*b*), the concrete made without any admixtures, having 125 kg cement and sand still containing dust. Curve *b* correlates with the concrete of curve *a*, but wiht an air-entraining agent added. Curve *c* depicts a concrete which, beside admixing an air-entraining agent, was made with dust-free sand. Thus it was possible to manufacture a frost-resisting concrete with a cement content of 125 kg.

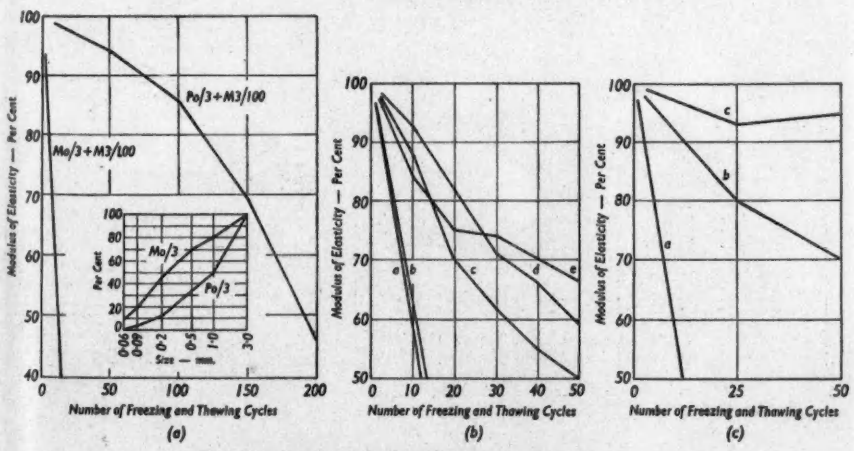
There is, of course, a limit to the reduction of the cement content in mass concrete subject to relatively low stress. This limit is determined by the watertightness and workability of the concrete. The authors specified that for the dams of the Glockner-Kaprun scheme a concrete could be considered watertight if test slabs measuring 40cm by 40cm by 20cm resisted water pressure, acting upward over a circular area of 10cm in diameter. The pressures were graduated as follows :—

1 atmosphere	24 hours
5 atmospheres	24 hours
10 atmospheres	24 hours
15 atmospheres	7 days

There should appear no moist patches or beads on the surface of the slab while testing. Immediately after the tests the slabs are split and visible moist patches should not extend over more than half of the cross-sectional height.

Concrete with a cement content of 225 kg is in conformity with these rules. With the progressive reduction of the cement content more moisture appears on the surface and a concrete with a cement content of 125 kg becomes completely soaked after the first pressure stage. Admixtures which considerably improve the workability increase the watertightness to a certain extent, so that, for instance, concrete with 125 kg cement is fully soaked only in the second stage if admixtures are used. In the gravity dam the watertightness of the core concrete is not of decisive significance, the facing concrete with a cement content of 250 kg being considered watertight.

(*To be continued*)



(*a*)—Effect of sand grading on freezing resistance.
(*b*)—Effect of cement content on freezing resistance, with the following :—

kg/m³		kg/m³	
125	*a*	250	*c*
150	*a*	275	*d*
175	*b*	300	*e*
200	*b*		

(*c*)—Effect of admixture and dust-free sand on freezing resistance.

Fig. 11—Variations in the modulus of elasticity of concrete subjected to freezing tests

Collapsible Packing Containers

Great savings in packing costs and increased safety of the consignments are claimed to be achieved where collapsible metal packing containers are used. The design made by the Düsseldorf firm of Postbox G.m.b.H. has been in use for some time, particularly on the German railways which operate a hire service. An example of such a case made by Postbox—a member of the Mannesmann group—is shown, in a partially dismantled state, in the accompanying illustration.

These containers range from approximately 0·42 cubic foot and 2·1 lb weight to 16·3 cubic feet and 70 lb weight. Made from steel or light alloy, they have carrying capacities up to 400 lb.

Components of the box are permanently hinged together and can be assembled in a very simple manner. As can be seen, the inside is

Collapsible metal packing container partially dismantled. The permanently hinged components fold down flat

smooth without any projections which might involve a reduction in the available space and possibly danger to the contents. The lid is closed by two lock links which are sealed by means of wire and lead seals. The label has the sender's name and address on the reverse side, thus obviating the need of writing out the address each time. The larger sizes of case are equipped with wooden sliding strips. In order to provide protection against dampness, plastic bags are available to fit each size of case. Sole representative in the U.K. is Layford Trading and Shipping Company, Ltd., 7, Chesterfield Gardens, Curzon Street, London, W.1.

The Telephone in Switzerland

During last year the number of telephone subscribers in Switzerland increased by 50,638 to a total of 794,899, and the number of instruments installed reached 1·21 million. With a population of about 5,000,000 at the beginning of the year, there is therefore on average one telephone for every four inhabitants. The number of telephone calls increased by 57·8 million over 1954 to a total of 881·6 million, making an average of 178 calls per head per year. This compares with about fifty calls per head per year in France and West Germany, and over 300 in the U.S.A., Canada and Sweden. At the end of the year a total of 40,600km of underground cables were installed, comprising some 5·8 million km of wire.

The American Scene

BY OUR AMERICAN EDITOR

Peace in the Steel Industry

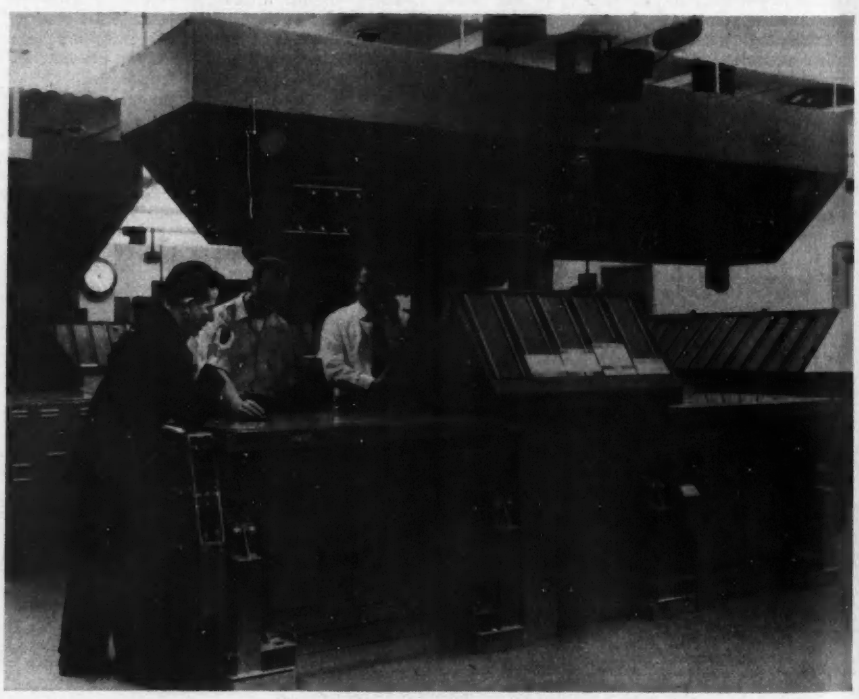
EARLY last month, one after the other of the American steel companies signed their various individual new contracts with the union. Exactly four weeks after the United Steelworkers of America called out its members in works producing nearly 90 per cent of American steel, an agreement was reached that promises peace in the industry for three years. At issue in the strife were wages and other benefits for the 650,000 union members employed in producing steel. The union originally sought a two-year agreement with the right to reopen wage clauses in 1957, and a minimum "package" increase of around 25 cents an hour. Management asked for an iron-clad, five-year, no-strike agreement, with annual pay increases averaging 6 cents an hour and no provision for reopening wage clauses except in case of a national emergency. Initially, due to management's refusal to compromise, the negotiations were broken off sharply. Then the Administration began applying pressure for a settlement. After a Cabinet meeting, word was relayed to management and labour of President Eisenhower's deep concern over the possible effects of a continued strike on the national economy. The Secretary of the Treasury was reported to have urged the industry to improve its offer, assuring its leaders that President Eisenhower would invoke the Taft-Hartley Act if the union held out against a better offer. Then, just as Mr. David MacDonald, the head of the Union, was preparing to leave Pittsburgh on a tour of strike centres management spokesmen requested a resumption of negotiations. The final round of meetings began the following day, and the union's wage policy committee approved the settlement three days later. These were the main terms of the agreement: (1) Direct wage increases averaging 10·5 cents an hour this year and 9·1 cents an hour in each of the two succeeding years; (2) an escalator provision adjusting the wage rates to changes in the cost of living; (3) a supplementary unemployment pay provision which guarantees laid-off workers with two years' seniority partial pay for up to fifty-two weeks a year; (4) premium pay for Sunday work; (5) a stronger union shop clause, as well as liberalised pension insurance and holiday benefits. The industry estimated the total value of the package at 52 to 55 cents an hour by 1958. The union set that value at 45·6 cents an hour. Mr. MacDonald estimated that over the three-year contract the total gain in all benefits would be 1332 million dollars.

Such staggering figures clearly indicate that American labour has won another great victory. From management's point of view, the most satisfactory part of the agreement is, obviously, the three-year term, which should ensure uninterrupted operations at a time of vast works expansions when continuous operations are of more than usual importance. The steel companies had asked for this assurance over a period of five years, but in getting only three there has nevertheless been introduced an element of stability which had been unfortunately lacking under former practices, when contract renewals came up at the end of each June. But what is the price industry has to pay for this long-term peace? It is clearly a high one. The wage policy committee hailed the settlement "as the greatest victory ever achieved by the U.S.W. in its twenty-year history." In the committee's view, it "not only represents the largest wage and fringe package ever negotiated by the union, but also achieves a historic break-through in the basic steel industry on week-end premium pay, a fifty-two-week supplemental unemployment compensation plan, and a union shop provision requiring all new employees to join the union." There can be no doubt that labour has cause for elation. But this is, of course, only half the story, and more time is still required for the remainder to unfold. For, not even a victorious union can get something for nothing, and the public still awaits the bill it will have to pay in the fulfilment of its part of innocent bystander to this controversy. Even Mr. MacDonald, who admits of no relationship between higher wages and higher prices, concedes that the increase in steel prices will be "substantial." In past years each wage increase in the American steel industry has been reflected in higher prices for steel, resulting in a price of about 130 dollars a short ton at the time of the strike.

Thus, as the strike ended, the big question was what effect the settlement would have on the tempo of what has been called the present "creeping inflation" in the United States. Wages in the steel industry have gone up, steel prices have been raised by the producers to match—8.50 dollars per ton following the present wage increase—and the inflationary economic merry-go-round which has distinguished the post-war years is continuing uninterruptedly on its care-free way. Undoubtedly the effect of the settlement must be to accelerate the inflationary spiral by another several notches, not only because it embodied "the largest wage and fringe package ever negotiated by union," but because, steel being the most basic of basic industries, the effects of the action are bound to permeate the whole American economic fabric. It cannot be claimed that this trend has not been apparent in the past. When these negotiations started it was to be expected that they would have a decided bearing on the course and pace of future developments. The success of labour in obtaining inflationary concessions in other industries virtually assured that, whatever the terms of the steel settlement, it would add some further impetus to the movement. The principal uncertainty lay in the matter of degree. Industry's first offer was clearly above the rate of productive expansion and thus inflationary in its implication. Nevertheless, it did not appease labour's appetite, nor did it appear excessive to those in Washington who "put the heat" on the companies to better the offer. A prosperous and overly complacent public has taken the ultimate decision with its customary indifference and a shrug of the shoulder. That the final agreement resolving this latest of American industrial controversies thus rests on the widest of bases does not, of course, alter the simple fact that it has had its origin in the demands of the union and in the union's refusal to adopt a more moderate attitude. So, while the responsibility for its effects are rather widely shared, the union is foremost in accountability for the consequences. They must inevitably be serious, and the only way they can be supported is by the maximum possible rise in productivity.

Long Range Radar Installation at New York International Airport

A SET of radar equipment made by the General Electric Company, of Schenectady, New York, recently was installed at the Civil Aeronautics Administration's new air route traffic control centre at the New York International Airport. The so-called "FPS–8" equipment has increased the range for controlling aircraft

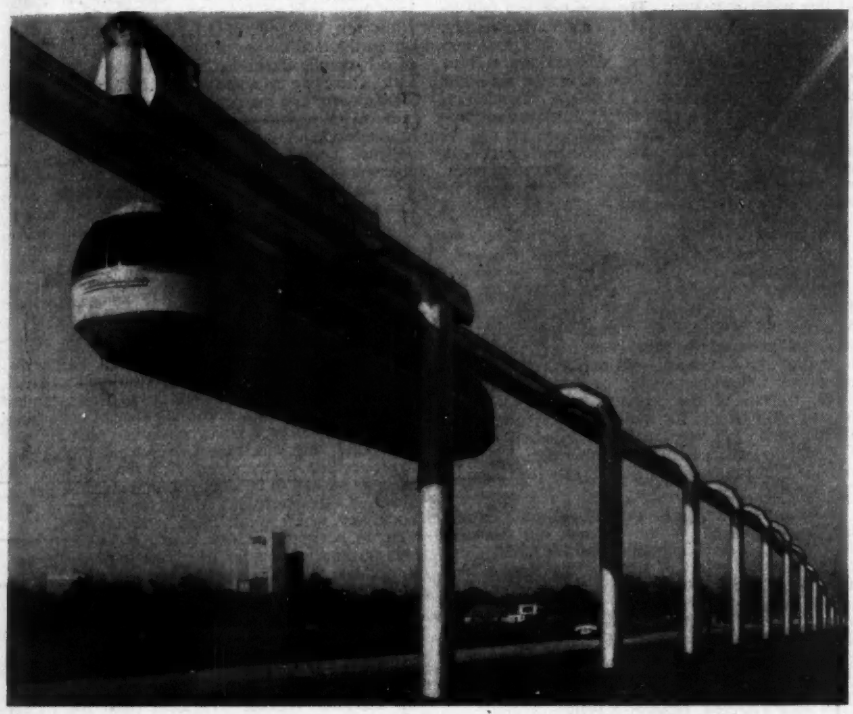


General Electric long-range radar installation at Traffic Control Centre of New York International Airport

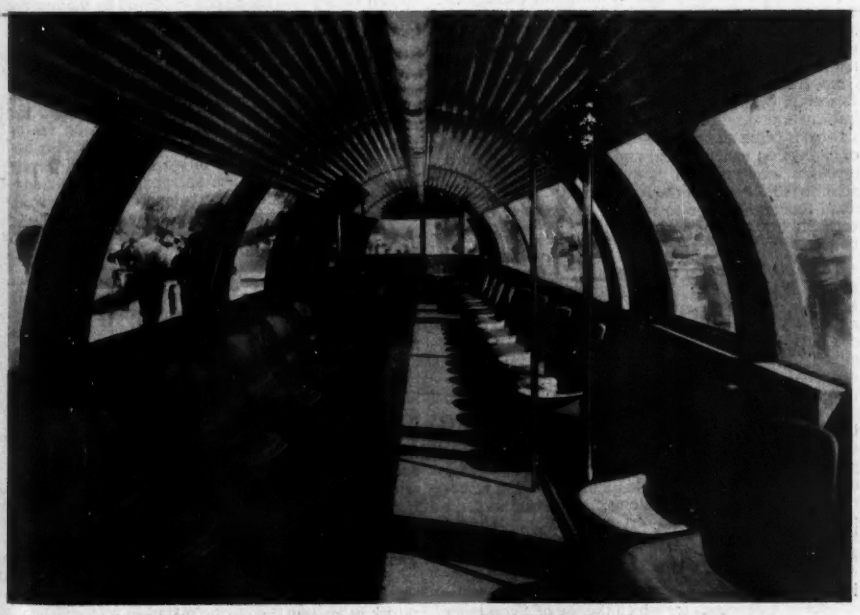
from the centre to over 100 miles in all weather conditions. The equipment was originally developed for the U.S. Air Force and was designed as a long-range search radar. According to the firm, the " FPS–8 " set has a range far greater than that of any other radar in use to-day at commercial American airports and will appreciably assist the air route traffic control service. The design of the unit was modified to meet the needs of air route traffic control, and provisions have also been made for the future installation of dual equipment. The air route traffic controllers are presented with a picture of all aircraft within a radius of over 100 miles by means of radar scope presentations situated in the control centre. Six of the thirteen radar scopes are horizontal and present a magnified picture. This provides the controllers with a means of marking by plastic tabs the identity and progress of each aircraft entering or leaving the New York metropolitan area. With normal two-way wireless communications, pilots are advised of their position and progress in relation to the other aircraft visible to the controllers on the radar scopes. Because the aircraft can actually be seen on these radar scopes at the centre, arrivals and departures at any of the six metropolitan New York airports can be made much more expeditiously than before. The metropolitan airports involved are the New York fields of LaGuardia, Idlewild, Mitchell Air Force Base, and Floyd Bennett Naval Air Station, and the new Jersey fields of Newark and Teterboro.

The " FPS–8 " equipment will work in conjunction with shorter range radars situated in the control towers at Newark, Idlewild, LaGuardia and Mitchell to monitor the arrivals and departures at all six terminals under both instrument flight rules and visual flight rules. These are two " rules," or laws, which must be obeyed by all pilots ; Instrument Flight Rules (IFR) apply when visual reference to the ground cannot be safely maintained ; Visual Flight Rules (VFR) in all other situations. It will allow the air route traffic controllers to advise pilots operating under IFR conditions of all other observed traffic since all aircraft are visible to the controllers on the thirteen radar indicators in the centre. Such close surveillance can lead to a virtual elimination of the procedure of " holding " or " stacking " aircraft to provide for safe movement and the traffic delays which result therefrom.

Aircraft are required to " post fixes " as they fly over air navigation facilities situated along their air routes, or airways. The postings give essential data to the air route traffic control centre regarding their flights, including their time of arrival over a given fix, their altitude and their estimated time of arrival over the next fix. Without the use of the long-range radar, an aircraft flying under IFR conditions cannot pass a fix for at least ten minutes after another aircraft has passed over the same fix unless it has a 1000ft altitude separation from the other aircraft. If both aircraft are cruising at 360 m.p.h., ten minutes means a 60-mile longitudinal separation. In 1958, when 600 m.p.h. cruising speeds will apply, ten minutes then becomes a 100-mile separation. With the use of the " FPS–8 " radar only 5 miles of longitudinal separation between aircraft is required. Thus, in bad weather, the unit can expedite aircraft arrivals at the terminals so that the acceptance rate of air traffic entering a New York airport may be increased to the physical acceptance limits of the airfield itself, within the legal landing ceiling and visibility restrictions applicable to that airport. Departures can also be expedited as the " FPS–8 " radar, in conjunction with the radar in the control towers, is able to monitor the aircraft leaving the metropolitan airports until they have reached their assigned cruising altitudes. This permits the elimination of the ten-minute longitudinal airspace separation here also.



Test run of monorail line at Houston, Texas



Interior of monorail demonstration coach

Test of Monorail Line in Texas

THE accompanying illustrations show an aerial coach which was recently operated as part of a demonstration of a monorail line at Houston, Texas. The 970ft long test installation is of the design which Monorail, Incorporated, 4118 Fannin Street, Houston, Texas, plans to fabricate and build, for lease or sale to transit companies or authorities. The aerial coach, which seats sixty passengers, is said to be a radical departure in design and operation. Its construction makes use of what the builders call " concentric suspension " and consists primarily of a series of suspended concentric steel rings braced by an arrangement of longitudinal steel stringers.

The oval-shaped coach is capable of a speed of 100 m.p.h. with its present power—two 305 h.p. internal combustion petrol engines. However, diesel or electric motors can be used, and the rails and towers have been designed so that the coach, with suitable power, can travel at a much greater maximum speed. Eighteen 30ft high inverted " J "-shaped steel towers with bell bottoms support the rail beam. These cylindrical towers are spaced 55ft centre-to-centre. There is an 18ft clearance above the ground. One end of the rail slopes down so that the coach can rest on the ground while taking on passengers. The steel-ribbed coach, which weighs 26,700 lb, is 54ft long, 8ft wide, and has an inside height of 7ft. It is almost completely covered with a skin of reinforced polyester resin. The remaining part of the surface is glazed with a tinted translucent plastic. The coach is equipped with automatic electric brakes and couplings, and carries a 7-ton air conditioning system. The driver-operator, sitting in a dome on top of the coach, is able to see the entire track area. The coach is operated much like an automobile, but uses only two gear shifts instead of four or five. It has eight pneumatic rubber tyres that lock on the rails. On top of the rail is a locking guide rail. If there should be a blow-out, one of the eight auxiliary wheels takes hold.

Personal and Business

Appointments

Mr. M. Russell has been appointed general manager of Duncan Watson (Electrical Engineers), Ltd.

Mr. W. A. Burnside has been appointed sales manager of R. B. Pullin and Co., Ltd., Brentford, Middlesex.

Dr. John Menzies Kay has been appointed to the Chair of Nuclear Power, tenable at the Imperial College of Science and Technology.

Mr. E. W. Ditchburn, M.I.Mech.E., is taking up an appointment with British Manufacture and Research Company, Ltd., Grantham.

Dr. Walter Kurt Hayman has been appointed to the Chair of Pure Mathematics, tenable at the Imperial College of Science and Technology.

Sir Peter Roberts, Bt., is to be installed, on October 2nd, as the 321st Master of the Company of Cutlers in Hallamshire. Sir Peter is chairman of Newton, Chambers and Co., Ltd., Thorncliffe, near Sheffield.

The Stanton Ironworks Company, Ltd., states that Mr. R. E. Stevenson has been appointed manager at the sales office at 22, St. Mary's Street, Cardiff (telephone, Cardiff 21876). He succeeds Mr. R. G. Saunders who has retired.

Mr. John Ryan, vice-chairman of the Metal Box Company, Ltd., and Mr. H. V. Stammers, deputy chairman of the British Tabulating Machine Company, Ltd., have been elected vice-chairmen of the British Institute of Management.

Bruce Peebles and Co., Ltd., Edinburgh, states that Mr. W. B. Laing, M.I.E.E., director and general manager, has been appointed managing director. Mr. G. Henderson, A.M.I.E.E., sales manager, and Dr. C. W. Marshall, M.I.E.E., have been appointed to the board.

Hon. Hugh W. Astor has joined the board of Universal Shipyards (Solent), Ltd. This company, hitherto known as Universal Launches, Ltd., has purchased premises at Sarisbury Green, Nr. Southampton (telephone, Locksheath 3272), which were formerly occupied by Solent Shipyards, Ltd.

Newton, Chambers and Co., Ltd., Thorncliffe, near Sheffield, states that Mr. S. C. Tyrrell and Mr. K. E. Walker have been appointed to the board of directors. Mr. Tyrrell is assistant managing director (excavator division), and Mr. Walker, assistant managing director (engineering division). Mr. S. L. Waide has been appointed assistant managing director (chemicals division).

Business Announcements

Foundry Services, Ltd., is opening its new works at Drayton Manor, near Tamworth, next week.

Mr. Lawrence Robson, chairman of Associated British Engineering, Ltd., has begun a world tour.

Firth Brown Tools, Ltd., Sheffield, has opened a warehouse at 2, Warwick Place North, Warwick Way, London, S.W.1.

Alfred Herbert, Ltd., Coventry, states that "Heald" machines (for which it is sole agent) are now being made in this country by Heald Machines, Ltd.

Chamberlain Industries, Ltd., Staffa Road, Leyton, E.10, states that its 50-ton horizontal bending machine is now marketed exclusively by Drummond-Asquith (Sales), Ltd.

Victoria Instruments, Ltd., Midland Terrace, Victoria Road, London, N.W.10, has taken over the control of Victoria Instruments, proprietors V.I.C. (Bournemouth), Ltd.

Rubert and Co., Ltd., Chapel Street, Stockport Road, Levenshulme, Manchester, 19, announces that it has taken over the sole agency for the German Martin high-speed hand grinders.

Urquhart's (1926), Ltd., is moving its registered office and works, on October 1st, to 5, Wadsworth Road, Perivale, Middlesex (telephone, Perivale 9511; telegrams, Oilburnia, Greenford, Middlesex). The Bristol office and works remain at Albion Dockyard, Bristol, 1.

Contracts

Folland Aircraft, Ltd., is to supply twenty-five "Gnat" light fighters to the Indian Government over a period of two years beginning April, 1957. Folland will also supply components and details to assist in the manufacture of similar aircraft, under licence, by Hindustan Aircraft, Ltd., at Bangalore. The "Gnat" carries two 30mm Aden guns and is powered with a Bristol "Orpheus" engine.

Woodall-Duckham Construction Company, Ltd., 63–77, Brompton Road, London, S.W.3, has received from the National Coal Board, North Eastern Division, an order for a new battery of coke ovens to be built at the Glasshoughton Works. The battery will consist of forty-two W–D Becker coke ovens, with a carbonising capacity of approximately 850 tons of coal per day and will include the necessary coal handling plant.

Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, has received from the Appleby-Frodingham Steel Company (a branch of the United Steel Companies, Ltd.), an order for electrical equipment worth about £350,000. This will be used on a new four-high reversing hot mill to be installed at the Appleby Steel Works, Scunthorpe. The mill will take steel slabs weighing up to 16,000 lb and roll them into plates up to 65ft in length and 11ft 4in finished width. The minimum plate thickness at this width is 0·30in. The new hot mill will be driven by two 4000 h.p., 40/100 r.p.m. d.c. motors, arranged as a twin-motor drive capable of a maximum total output of 24,000 h.p. The motors will be supplied from a 6400kW flywheel motor generator set having a peak capacity of 19,200kW. In addition to being responsible for the supply, erection and commissioning of the main electrical machines, control equipment and cables, Metropolitan-Vickers will also act as main contractor for the ventilating plant, which will supply 500,000 cubic feet per minute of filtered air to the machines and substation.

Miscellanea

Medway Towns By-Pass.—We learn from the Ministry of Transport and Civil Aviation that the Minister, Mr. Harold Watkinson, has considered representations which have been made to him in favour of the construction of a North Kent single motorway following the line of the chalk escarpment, instead of the separate by-passes for the Medway Towns and for Maidstone, Leybourne and Ditton which are supported by the Kent County Council and the other local authorities. He has decided, in principle, in favour of the separate by-passes.

Italian Concrete Structures.—A visit to Italy has been arranged by the Cement and Concrete Association's Joint Committee on Structural Concrete, with the object of showing British architects and engineers something of the work being done to-day in that country. The tour, which will last a week, will cover Milan and its environs, Florence, Genoa, the Ligurian coast, Turin, Bergamo and Ivrea, from September 30th to October 6th. Those interested should communicate with the Joint Committee on Structural Concrete, Terminal House, Grosvenor Gardens, London, S.W.1.

Technical Advisory Service.—The technical knowledge and experience of a number of Birmingham's larger firms, the trade research associations, Birmingham University and Birmingham College of Technology, are being made directly available to local industry through a new technical advisory service. This service has been set up by the Birmingham Productivity Association with the aid of a grant from the Department of Scientific and Industrial Research, which has also placed its resources of information at the Association's disposal. The scheme is being administered by a standing committee of experts on technological and managerial problems through a permanent technical advisory officer attached to the staff of the Association. The service's main function will be to provide an effective liaison between firms requiring assistance and the sources best equipped to give it.

Digital Computer for Research.—The University of Sheffield and the United Steel Companies, Ltd., have come to an agreement for the purchase and installation of a Ferranti "Pegasus" digital computer, The £50,000 computer, which has already been ordered from Ferranti, Ltd., is to be delivered in March, 1958, and will ultimately be installed in a new mathematics block at the University, for which approval has just been given. The University and the United Steel Companies, Ltd., will use the machine for their own research programmes. The University plans to undertake, for example, many kinds of stress calculation for structural and mechanical systems, heat transmission problems and work on crystallography. United Steel's research and development department at Rotherham will use the computer for a variety of research calculations. Apart from this, the company is engaged on operational research combined with the science of cybernetics for which the use of a computer is essential.

Lightweight Breathing Apparatus.—Normalair, Ltd., has developed a light-weight oxygen equipment for small passenger machines and gliders. The control unit weighs less than 1 lb, and can be set to give flows of 1, 2, 3, 5 or 10 litres per minute. The face mask has a breathing bag attached and can be worn without a helmet. The cylinders are charged to 1800 lb per square inch and can hold 400 or 750 litres, weighing 8·8 lb or 12·7 lb, respectively. These sets were used on all the Slingsby sailplanes participating in the recent World Gliding Championships, and were on several occasions flown to over 20,000ft. Normalair also produces portable lightweight breathing sets of 100, 120 or 200 litres capacity with disposable plastic masks, which are intended for use when moving around aircraft under emergency conditions: flow rates of 2, 4 or 10 litres per minute are afforded.

Rectification of Large Cylinders.—Particulars have been received from Nicol and Andrew, Ltd., Hillington, Glasgow, of a recent contract it carried out in the rectification of two large steam cylinders of a hydraulic intensifier at the works of Colvilles, Ltd. These two cylinders were each 68in diameter by 7ft 6in deep, and the rectification work involved the removal of scoring and ovality with the cylinders *in situ* during a holiday period. For the job the firm designed portable internal grinding heads for the diameter of 68in, with special vertical drives to permit a stroke up to 8ft. Each grinding head weighed over 1 cwt and was raised and lowered by an inching motor, while torque was applied through a differential drive. The ovality over the cylinders was 0·050in. and stock removal averaged 0·070in over a surface area of approximately 40 square feet for each cylinder, and the repair was completed to an accuracy of 0·005in, which was considered adequate.

Regrouping Water Undertakings.—During a recent tour of Wales, Mr. Enoch Powell, Parliamentary Secretary of the Ministry of Housing and Local Government, said that experience in Cardiganshire illustrated the advantages of the policy of regrouping water undertakings, a policy which had been in effect since 1945, and which the Government was hoping to see realised more rapidly. At a time when capital expenditure had to be strictly scrutinised, Mr. Powell observed, the suitability and competence of the bodies by which sums, often relatively very large, were to be spent on new works for water supply was obviously a matter of public importance, and in deciding whether or not to sanction a scheme the Government would have to take into account what progress in regrouping had been made, or appeared likely to be made, in the near future. Money must not be sunk in separate local schemes, where larger and better schemes would be produced by regrouping.

Conditions of Contract in Overseas Civil Engineering Works.—We learn from the Export Group for the Constructional Industries that conditions of contract for overseas works, mainly of civil engineering construction, have been prepared by the Association of Consulting Engineers jointly with the Export Group and have been approved by the Institution of Civil Engineers. These organisations have devised standard conditions which should be of great assistance to employing authorities and others responsible for carrying out development programmes. The conditions have as their objective, it is stated, a clear and logical sequence of clauses, the removal of ambiguities, the elimination, so far as possible, of speculative elements and a fair distribution of the risks inherent in works executed largely below ground level. It is anticipated that the conditions, which hold the balance fairly between employers and contractors, will secure a wide measure of acceptance as there has been a demand for such a document for some considerable time.

Water Development and Irrigation in Northern Rhodesia.—The annual report for 1955 of the director of the Water Development and Irrigation Department of Northern Rhodesia gives a brief account of further progress in that territory in the development of water conservation works. The department is responsible for sinking wells, building and maintaining impounding structures, and also for reconnaissance and survey of available sources of water. Activity in all these classes of work is reported during 1955. An experiment which so far has given encouraging indications is the recovery of potable underground water from the Karoo sands of the Barotse Protectorate by "well points." The well point is in effect a tube with a drive point, a foot or so above which are perforations protected by a strainer. The tube, driven into the water-bearing stratum, can be fitted with a hand pump. Should these prove successful a large number of water sources of doubtful purity at present in use in the Protectorate will be replaced by these hygienic points, it is stated.

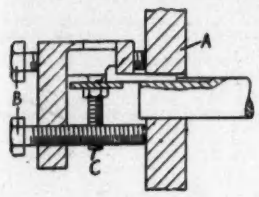
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

WORKSHOP TOOLS AND APPLIANCES

755,623. November 5, 1953.—EXTRACTORS FOR REMOVING KEYS FROM KEYWAYS, David Collings, 88, New Church Street, Castleton, Rochdale.

The invention relates to improvements in extractors for removing keys from keyways in pulleys, in flanges and other machine parts. As will be seen from the drawing, it is of rectangular construction, built up from side members and transverse members. The



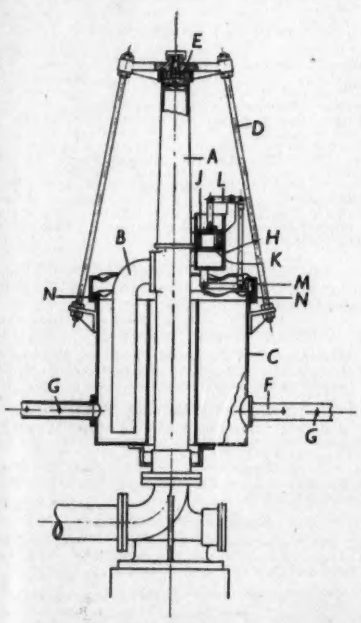
No. 755,623

transverse member *A* is slotted and has a recess which receives the head of the gib key. The side members have lugs through which screwed rods pass as shown. Further screwed rods *B* pass vertically through a plate which prevents the extractor from tipping. In order to extract a key the gib head is inserted over the forward transverse member and the screwed rods *B* are advanced to engage the face of the pulley, and the rods *C* to clamp the head of the key. By rotating the screws *B* the key is extracted expeditiously without damage. The transverse members may be of different widths.—*August* 22, 1956.

CIVIL ENGINEERING

755,550. March 3, 1954.—REVOLVING SEWAGE DISTRIBUTORS, Charles Robert Barrington Brown, c/o Tuke and Bell, Ltd., Engineers, Beacon Street, Lichfield.

The invention relates to apparatus for controlling the speed of rotation of sewage filter distributors. One or more dashpots between the fixed non-rotating centre column of the distributor and the rotating distribution arms are so coupled that the speed of rotation of the distribution arms about the



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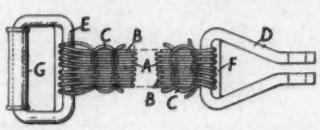
column is governed by the rate of movement of the dashpot piston, which, in turn, is controlled by the passage of the dashpot liquid through an orifice. As will be seen from the drawing, *A* is the fixed non-rotating centre column up which the liquid sewage flow and passes to the port *B* delivering to the receiving chamber *C*. This chamber is carried by suspension rods *D* connected to ball bearings *E* at the top of the column. *F* are the distribution arms, *G* the discharge orifices. *H* is the dashpot cylinder, *J* the piston, and *K* the orifice through which the dashpot liquid passes alternately in both directions as the receiving chamber and distribution arm or arms rotate about the centre column. *L* is the operating lever system provided with a roller wheel *M*. *N* is the switchback track fixed to the receiving chamber. A modified design of the mechanism is also shown in the specification.—*August* 22, 1956.

CRANES AND LIFTING APPLIANCES

755,438. February 16, 1954.—LIFTING SLINGS, British Electrical Repairs, Ltd., 10, Charlotte Street, Manchester, 1. (*Inventor: Cecil Thomas Marsh.*)

Referring to the drawing, the lifting sling comprises a strip *A* consisting of a wire rope or cable plaited or woven into a flat band made from one length, the end parts of which form the transverse strands *C*. The longitudinal strands *B* form loops at the ends of the strip which pass round the transverse parts of a triangular end connecting link *D* and of a reeving end



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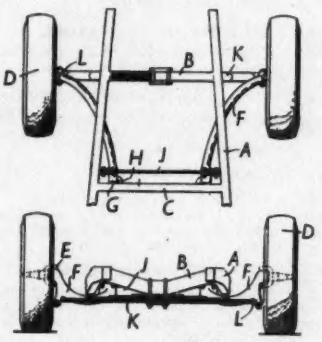
buckle *E*. The strands *B* lie side by side where they pass round the parts and are located so as to avoid deformation of the strip *A* by combs *F*. The buckle has a roller *G* on its side opposite the comb on which the strip can run when threaded through the buckle. The link *D* may be open at its apex or closed. For suspending lengthy articles two or more slings may be used. The specification also describes slings for lifting square articles and bundles of steel rods.—*August* 22, 1956.

ROAD TRANSPORT

755,708. November 11, 1954.—AUTOMOBILE SPRING SUSPENSION, Victor Heron, 75, Buckingham Drive, Riverside, Ontario, Canada.

The invention relates to automobile spring suspensions—that is, to arrangements of links and springs for guiding the wheels of an automobile relative to the frame as they move up and down in response to



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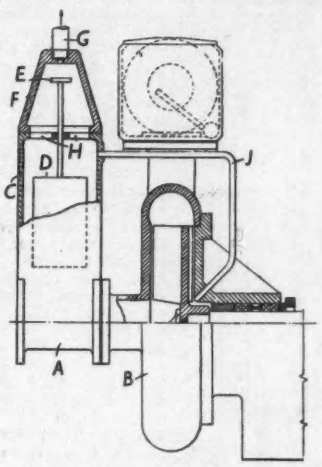
irregularities in the road and for transmitting the weight of the spring-supported part of the automobile to the wheels. As shown in the drawing, a conventional automobile frame includes side rails *A*, a front cross member *B*, and a second cross member *C*. Each of the two front wheels *D* is carried on a steering knuckle *E* pivoted on the forward end of a longitudinal swinging arm *F*. The rear end of each arm has a bracket *G* fixed to it, and each bracket is pivoted by means of a rubber bushing to another bracket *H* that is fixed to the second cross member *C* of the frame. The two swinging arms *F* are connected together at their rear ends by a flat piece of spring steel *J*, whose ends are firmly fixed to the ends of the arms by the brackets *G*. The spring *J* lies in a vertical plane extending across the automobile, so it prevents either of the two arms *F* from turning about an axis along the length of the automobile. However, by bending slightly in a horizontal plane, the spring permits the arms to swing sideways a little, and, by twisting, it permits either of the arms to swing up or down relative to the other. Swinging of both arms up or down together can take place without any twisting of the spring. The arms *F* are held against swinging sideways and are pressed down by a simple transverse leaf spring *K* fixed at its centre to the underside of the front cross member *B* of the frame. The ends of the spring *K* are pivoted (not shackled) to extensions *L* of the longitudinal arms *F*, the pivots being as low and as close to the wheels as practical. These pivots also can have rubber bushings, and rubber pads can be used under the tips of the spring leaves, so that there need be nothing in the suspension (not including the wheel bearings and the steering pivots) that needs to be oiled or greased.—*August* 22, 1956.

PUMPS

755,249. February 22, 1954.—CENTRIFUGAL PUMPS, Henry Sykes, Ltd., and Harold Philip Sidney Paish, both of Southwark Street, London, S.E.1.

The invention relates to centrifugal pumps, and more particularly to self-priming arrangements, which include a vacuum pump connected to the suction side of the centrifugal pump. It is particularly



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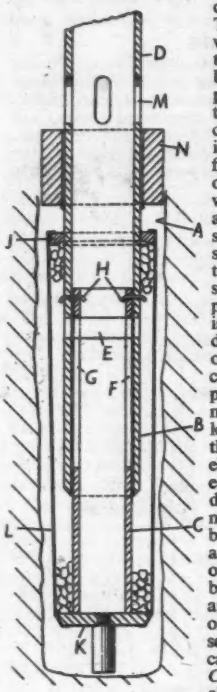
applicable to a centrifugal pump having an open-sided single-entry impeller. As shown in the drawing, the suction pipe *A* of the centrifugal pump, of which the casing is shown at *B*, carries a float chamber *C* which is in communication with the suction pipe and contains a float *D* carrying a valve *E* located within a housing *F* mounted on the top of the float chamber, a vacuum pipe *G* being connected to the housing. The other end of pipe *G* connected to a vacuum pump creates a vacuum within the housing *F*, and, through apertures *H*, also in the float chamber *C*, so that the water level in it rises and at the same time rises in the casing *B* to prime the pump. When the water level has risen to the required extent the valve *E* closes the lower end pipe *G*, thereby shutting off the suction at that point. The upper part of the float chamber *C* is connected according to the invention by a pipe *J* to the centrifugal pump casing at a point which is above and near the back of the boss of the impeller. Any air leaking through the pump gland is removed through pipe *J* to the upper part of float chamber *C* causing the water level in the float chamber to fall and the float *D* to open. Thus, air leaking through the gland is led direct to the vacuum pump without in any way interfering with the efficient operation of the pump, which in operation discharges through a non-return valve in the casing *K*.—*August* 22, 1956.

MINING ENGINEERING

755,669. April 9, 1954.—ELECTRODES FOR THE UNDERGROUND GASIFICATION OF COAL, The Minister of Fuel and Power, London. (*Inventor: Geoffrey Hart.*)

The invention relates to electrodes for use in systems for the underground gasification of coal in which considerable electric current is passed through the coal seam. The main object is to provide such an arrangement whereby a good electrical contact between the current-carrying electrode and the coal seam can be ensured, and a method of establishing such a contact by operations performed from or above the ground surface. In the drawing, *A* shows the lower part of a bore-hole extending into a coal seam. The electrode comprises a pair of telescoping cylinders *B* and *C*, the upper cylinder *B* being the outermost. A long conducting member or barrel *D* extends from the cylinder *B*, carries current to the cylinders, and raises and lowers them. The cylinders *B* and *C* are rendered incapable of relative rotation by a peg *E* extending across the cylinder *B* through vertical slots *F* and *G* in the cylinder *C*. The cylinders are held in the extended position by shear pins *H*. The cylinder *B* carries an abutment collar *J* somewhat smaller in diameter than

the bore-hole, the lower surface of the collar being tapered as shown, and the cylinder *C* carries a footplate *K* slightly smaller in diameter than the collar. A sleeve *L* of perforated metal of low melting point—for example, zinc—surrounds the cylinders, the ends being lapped over the collar and footplate. The sleeve forms a container for broken carbon which fills the annular space between the cylinders, the collar, footplate and sleeve. The sleeve *L* is slashed with vertical cuts to facilitate collapse. The tubular barrel or conductor *D* is provided with slots *M* for the passage of gas and carries at suitable places insulating rings *N* which fit loosely over it and rest on projections formed by welding. In action, the assembled electrode and insulating rings, as necessary, are lowered to the bottom of the bore-hole. In some cases the desired final position of the electrode is such that the footplate *K* does not rest at the bottom of the bore-hole and in such circumstances a distance piece of insulating material made to an appropriate length is attached below the footplate before the electrode is lowered. When either the footplate or distance piece, as the case may be, reaches firm bottom the electrode assembly is usually capable of rotation. A few vertical blows of moderate strength are then applied to the top of the barrel *D*, which severs the shear pins and causes the cylinders *B* and *C* to telescope whereby the abutments *J* and *K* move towards one another and compress the broken carbon and collapse the sleeve *L* outwards, forcing both into good contact with the exposed coal surface in the bore-hole. The formation of contact may be checked by the fact that the electrode assembly is no longer free to rotate and may be confirmed by electrical measurements. During operation any steam or gas generated escapes around the outside of the collar *J*, around the insulator rings, through the slots *M* and up the inside of the conductor member or barrel *D*. The peg *E* also enables the cylinder to be recovered from the bore-hole with the rest of the parts after use. —*August* 22, 1956.



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METALLURGY

755,525. September 29, 1953.—CHILLING CAST BILLETS OF METALS, Gebr. Böhler and Co. Aktiengesellschaft, Elisabethstrasse 12, Vienna, 1, Austria.

The invention relates to a process for cooling continuously cast billets of metals of high melting point, such as steel, outside the mould in continuous casting plants. It is by spraying the billet with a cooling liquid from the point where it leaves the mould to the point where it is completely solidified. Only such a quantity of heat is withdrawn that the temperature of the marginal zone remains substantially constant from the leaving of the chill-mould to the solidification of the core, or falls gradually through not more than 200 deg. Cent.—*August* 22, 1956.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF PUBLIC LIGHTING ENGINEERS

To-day, Sept. 21st.—Blackpool, Annual Conference, 1956.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Sat., Sept. 22nd.—OXFORD, READING AND DISTRICTS BRANCH: Collier Lecture Room, Regents Park College, Pusey Street, Oxford, "The Control of Automation," L. Meeks, 6.30 p.m.

Wed., Sept. 26th.—BRIGHTON, HOVE AND DISTRICT BRANCH: New Imperial Hotel, First Avenue, Hove, "Earth Leakage Protection," J. A. Robbins, 7.30 p.m.——SOUTHAMPTON BRANCH: Visit to Pirelli General Cable Works, Eastleigh, 2.30 p.m.

Thurs., Sept. 27th.—PORTSMOUTH BRANCH: Royal Beach Hotel, Southsea, Open Meeting, Film of Fifth A.S.E.E. Exhibition, 7.15 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 26th.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Some Aspects of Transistor Progress," H. W. Loeb, 6.30 p.m.

Thurs., Oct. 4th.—N.W. SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, 1, "Education for Electronics," R. H. Garner, 6.30 p.m.

Fri., Oct. 5th.—S. MIDLANDS SECTION: North Gloucestershire Technical College, Cheltenham, "Television Lighting Effects," A. E. Robertson, 7 p.m.

Wed., Oct. 10th.—W. MIDLANDS SECTION: Technical College, Wulfruna Street, Wolverhampton, "Colour Television," 7.15 p.m.

BRITISH INTERPLANETARY SOCIETY

Sat., Oct. 6th.—York Hall, Caxton Hall, Caxton Street, London, S.W.1, "The Study of the High Atmosphere in the International Geophysical Year," H. S. W. Massey, 6 p.m.

CHEMICAL SOCIETY

Fri., Oct. 5th.—MANCHESTER BRANCH: Chemistry Lecture Theatre, The University, Manchester, "Corrosion Fatigue," U. R. Evans, 6.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Sept. 24th.—LEEDS CENTRE: Griffin Hotel, Boar Lane, Leeds, Annual Dinner and Chairman's Induction; Visit of President, W. E. Harper, 7 p.m.——LEICESTER CENTRE: E. Midlands Electricity Board, Charles Street, Leicester, "Interesting Lighting Jobs," papers by Centre Members, 6 p.m.

Wed., Sept. 26th.—TRANSVAAL CENTRE: Room 95, Public Library, Johannesburg, Chairman's Address, R. S. Yates, 8 p.m.

Fri., Sept. 28th.—BATH AND BRISTOL CENTRE: Royal Hotel, Bristol, "Lighting for Enjoyment," T. O. Freeth, 7 p.m.——BIRMINGHAM CENTRE: Regent House, St. Phillip's Place, Colmore Row, Birmingham, Chairman's Address, V. A. Heydon, 6 p.m.

Mon., Oct. 1st.—LEEDS CENTRE: Yorkshire Electricity Board Lecture Theatre, Ferensway, Hull, "Home Lighting," Jean L. Stewart, 7 p.m.

Wed., Oct. 3rd.—EDINBURGH CENTRE: Y.M.C.A., 14, South St. Andrew Street, Edinburgh, "Light Sources for Colour Matching," E. E. Miles and D. C. Peach, 6.15 p.m.——NEWCASTLE UPON TYNE CENTRE: Grey Hall, Department of Electrical Engineering, King's College, College Road, Newcastle upon Tyne, 1, Chairman's Address, P. S. J. Underwood, 6.15 p.m.——SWANSEA GROUP: S. Wales Electricity Board, The Kingsway, Swansea, Chairman's Address, G. J. Higgs, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Sept. 24th.—WEST AND EAST YORKS BRANCH: The University, Leeds, "Radiography in Industry," E. L. Grimwade, 7.30 p.m.

Thurs., Sept. 27th.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, Talk on a Large Civil Engineering Project, 7.30 p.m.

Fri., Sept. 28th.—S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, Films, "Lubrication and its Importance in Plant Engineering," 7.15 p.m.

Tues., Oct. 2nd.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "The Treatment and Disposal of Industrial Effluent," J. Lakin, 7 p.m.——EDINBURGH BRANCH: 25, Charlotte Square, Edinburgh, "Incentives for Maintenance," 7 p.m.

Wed., Oct. 3rd.—LEICESTER BRANCH: College of Art and Technology, Leicester, "Power Transmission," 6.30 p.m.——SOUTHERN BRANCH: Polygon Hotel, Southampton, Brains Trust on General Matters, 7.30 p.m.

INSTITUTE OF PETROLEUM

Wed., Oct. 3rd.—26, Portland Place, London, W.1, "Le Havre-Paris Pipeline," J. B. Capdeville, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 1st.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Operation and Development of Disc Brakes," T. J. Phippa, 7.30 p.m.

Tues., Oct. 2nd.—EASTERN CENTRE: Canteen, Eastern Counties Omnibus Company, Ltd., Norwich, "The Commer T.S.3 Two-stroke Diesel Engine," E. W. Coy, 7.30 p.m.

Wed., Oct. 3rd.—E. MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Current Trends in Fuel Injection Equipment for Road Transport," J. Skinner, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Sept. 25th.—PUBLIC HEALTH AND B.N.E.C. MEETING: Great George Street, Westminster, London, S.W.1, "The Problem of Liquid and Gaseous Effluent Disposal at Windscale," F. R. Farmer, 5.30 p.m.

Tues., Oct. 2nd.—AIRPORT MEETING: Great George Street, Westminster, London, S.W.1, "Prestressed Concrete Runways: History, Practice and Theory," A. J. Harris, 5.30 p.m.

Thurs., Oct. 4th.—LECTURE ON THE CONSERVATION OF NATURAL RESOURCES: Great George Street, Westminster, London, S.W.1, "Mineral Resources," W. R. Jones, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Thurs., Oct. 4th.—ORDINARY MEETING: Savoy Place, London, W.C.2, Inaugural Address as President, Sir Gordon Radley, 5.30 p.m.

Tues., Oct. 9th.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Chairman's Address, "The Measurement of Radioactivity," Denis Taylor, 5.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 2nd.—39, Elmbank Crescent, Glasgow, "Industrial Organisation," P. Hanika, 6.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS

To-day, Sept. 21st.—MANCHESTER AND DISTRICT BRANCH: Engineers' Club, Albert Square, Manchester, "Intermittent Heating in Buildings," E. Harrison, 6.30 p.m.

Tues., Sept. 25th.—BIRMINGHAM AND DISTRICT BRANCH: Exchange and Engineering Centre, Stephenson Place, Birmingham, "Electric Floor Heating," T. F. Cadman, 6.30 p.m.——SCOTTISH BRANCH: Scottish Building Centre, 425, Sauchiehall Street, Glasgow, C.2, "Principles for the Selection of Mechanical Stokers for Boiler Plant," E. J. Macdonald, 7 p.m.

Tues., Oct. 2nd.—N.E. COAST BRANCH: Institute of Mining and Mechanical Engineers, Neville Street, Newcastle upon Tyne, 1, Chairman's Address, 6.30 p.m.

Wed., Oct. 3rd.—E. MIDLAND BRANCH: College of Arts and Crafts, Waverley Street, Nottingham, "Medium Pressure Hot Water Heating," J. N. Saunders, 6.45 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Oct. 5th.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Highway Engineering from a County Angle," J. A. Cram, 5.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Sept. 26th.—GENERAL MEETING: Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, Presidential Address, J. F. B. Vidal, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Wed., Sept. 26th.—E. MIDLANDS BRANCH: Technical College, Lincoln, Reception by the Chairman, G. B. R. Feilden, 6.15 p.m.; Chairman's Address, 7 p.m.——YORKSHIRE BRANCH: Visit to W. C. Holmes and Co., Ltd., and Holset Engineering Company, Ltd., 2.30 p.m.; Technical College, Huddersfield, "The Influence of Some Design Factors on the Characteristics of Ball-Bearings and Roller-Bearings at High Speeds," A. Fogg and J. S. Webber, 7 p.m.

Fri., Sept. 28th.—N.W. BRANCH: Central College of Further Education, Abbey Road, Barrow-in-Furness, "Water Ring Self-priming Pumps," E. Crewdson, 7.30 p.m.

Mon., Oct. 1st.—N.E. BRANCH: Stephenson Building, Claremont Road, Newcastle upon Tyne, 2, Chairman's Address, Aubrey Burstall, 6 p.m.

Tues., Oct. 2nd.—S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, Chairman's Address, H. A. V. Bulleid, 6 p.m.

Wed., Oct. 3rd.—SOUTHERN BRANCH: College of Technology, Anglesea Road, Portsmouth, "Nuclear Reactors for Power Production," B. L. Goodlet, 6.30 p.m.

Thurs., Oct. 4th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "Testing of Boilers and Turbo-Alternators in Power Stations of the Central Electricity Authority," H. S. Horsman, 6.45 p.m.——SCOTTISH BRANCH: Technical College, George Street, Glasgow, "A Criticism of the Technical Education of Recently Qualified Engineers," P. P. Love, 7.30 p.m.——EAST MIDLAND GRADUATES' SECTION: Technical College, Lincoln, Film Evening, 7.15 p.m.

INSTITUTION OF NAVAL ARCHITECTS

Thurs., Oct. 11th.—Weir Lecture Hall, 10, Upper Belgrave Street, London, S.W.1, "Scale Effect Experiments on Victory Ships and Models," Part II, "Analysis of Wake Measurements on a Model Family and the Model Boat, D. C. Endert, Jr.," J. D. van Manen, 4.45 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Mon., Oct. 8th.—JUBILEE MEETING: Institution of Electrical Engineers, Savoy Place, London, W.C.2, President's Address, "Fifty Years of Telecommunications," 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., Sept. 25th.—OXFORD SECTION: Town Hall, Oxford, "Industrial Finishing Technique and Practice (Paints and Organic Coatings)," J. J. Stordy and W. G. J. Appleton, 7.30 p.m.

Wed., Sept. 26th.—SHREWSBURY SECTION: Technical College, Shrewsbury, "The Practical Application of Job Evaluation," E. H. Collins, 7.30 p.m.

Thurs., Sept. 27th.—NORTHERN IRELAND SECTION: Kensington Hotel, College Square East, Belfast, Chairman's Address, J. G. Easterbrook, 7.30 p.m.

Fri., Sept. 28th.—S. WALES SECTION: S. Wales Institute of Engineers, Park Place, Cardiff, "Induction Heating," R. H. Barfield, 7 p.m.

Wed., Oct. 3rd.—NOTTINGHAM SECTION: Victoria Station Hotel, Milton Street, Nottingham, "The 'ings' of Industry," W. H. Telling, 7 p.m.——S. ESSEX SECTION: Mid-Essex Technical College, Chelmsford, "Trade Unions and Industrial Development," R. Harle, 7.30 p.m.——COVENTRY GRADUATE SECTION: Craven Arms, High Street, Coventry, Production Panel, 7.15 p.m.

IRON AND STEEL INSTITUTE

Thurs. and Fri., Oct. 4th and 5th.—IRON AND STEEL ENGINEERS' GROUP: Thursday: Grand Pavilion, Porthcawl, "The Engineering Aspects of a Modern Basic Bessemer Plant," C. Herrmann, 9.30 a.m. to 12.15 p.m.; Seabank Hotel, Porthcawl, Luncheon, 12.30 p.m. to 1.30 p.m.; Visit to Margam (Blast Furnaces, Coke Ovens and Sinter Plant) and Abbey (Open-Hearth Steel Plant and Wide Strip Mills), Works of the Steel Company of Wales, Ltd., 1.45 p.m. to 4.45 p.m.; Staff Restaurant, Abbey Works, Dinner, 7.30 p.m.; Friday, Grand Pavilion, Porthcawl, "The Planned Changeover of a High-Lift Slabbing to a Universal Mill," C. E. H. Morris and R. N. Dale, 9.30 a.m. to 12.15 p.m.; Esplanade Hotel, Porthcawl, Luncheon, 12.30 p.m. to 1.30 p.m.; Visits to Margam and Abbey Works of the Steel Company of Wales, Ltd., 1.45 p.m. to 4.45 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Oct. 11th.—The Temple, Dale Street, Liverpool, Presidential Address, W. Rose, 7 p.m.

LONDON ASSOCIATION OF ENGINEERS

Sat., Oct. 6th.—Fullers' Restaurant, 206, Regent Street, London, W.1, "Atomic Energy and the Engineer," W. R. Wootton. Film of the New Atomic Power Station at Calder Hall, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Fri., Sept. 28th.—GRADUATES' AND STUDENTS' SECTION: 4, Hamilton Place, London, W.1, "Novel Methods of Take-off and Landing," T. J. Cummings, 7.30 p.m.

Mon., Oct. 1st.—DERBY BRANCH: Rolls-Royce Welfare Hall, Nightingdale Road, Derby, "Sir Henry Royce, Bt.," H. I. F. Evernden, 6.15 p.m

SOCIETY OF ENGINEERS

Mon., Oct. 1st.—ORDINARY MEETING: Geological Society, Burlington House, Piccadilly, London, W.1, "The Calder Hall Nuclear Power Station," K. J. Frost, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Sept. 25th.—MAIN MEETING: Manson House, Portland Place, London, W.1, Presentation of the Bowen Prize, "The Accurate Calibration of Flowmeters," E. A. Spencer and A. T. J. Hayward, 6.30 p.m.

Wed., Sept. 26th.—CHESTER SECTION: Chester and District Hospital Committee, 5, King's Buildings, King Street, Chester, "A Nuclear Power Station and its Instrumentation," K. R. Sandiford, 7 p.m.

Fri., Oct. 5th.—FAWLEY SECTION: Copthorne House, Fawley, Hants, "Electrically Operated Process Control Equipment," R. J. Redding, 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., Oct. 19th.—39, Elmbank Crescent, Glasgow, Symposium on the Application of Low-Alloy Steels for Welded Pressure Vessels, 10 a.m.